GENERAL ORTHOPEDICS

INCLUDING

SURGICAL OPERATIONS

BY

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INTRODUCTION.

A WORK devoted to modern orthopedic surgery will unquestionably be of great practical value to the physician and will fill a void. Marked progress has of late years been made in orthopedics, a branch of the surgical art, and on account of the frequency of deformities, it is a subject which should attract the attention of every thoughtful physician.

The physician who, during his student days, has not acquired the knowledge of and the readiness in applying bandages and apparatus will have cause for regret, for he will be frequently called upon to resort to these measures in his practice and it will not always be possible to send his patient to an orthopedic dispensary or surgeon. Although many deformities can only receive the requisite treatment at special clinics. or at the hands of the specialist who has acquired the essential technical skill, it still holds true that the subject, in general, should be the property of every physician. As v. Ziemssen says, "orthopedic methods belong to those which every physician should master; the technique should be thoroughly acquired and expertly understood." Further still, modern orthopedic methods are of greater importance to the physician than those of the past, when the more active operative measures were not countenanced to the same degree as obtained in other branches of surgery.

Owing to the fact that deformities are met with chiefly among the poorer classes, our aim should always be to resort to the simplest and cheapest therapeutic apparatus. Coulomb's words "il faut être démocrate du moins en orthopédie" are most apt ones, since the simpler the contrivance, the more accessible it will be to the majority of patients.

With truth did Bauer complain that many inventors take out patents for orthopedic apparatus, since "no liberal-thinking physician should place his inventions within the reach of the rich and deny them to the unfortunate poor." There is, however, scarcely any method of treatment with which fault might not be found; simplicity has rarely prevailed in orthopedics; ordinarily there is call for knowledge as to the technique of bandages and apparatus, for anatomico-physiological insight, for pathologico-anatomical research into the causal factors of deformities, in order to obtain a correct estimate of the obstacles in the way of treatment. The chief requirements, indeed, of our subject lie in a pathologico-anatomical and in a diagnostic direction.

I have borne in mind, in the preparation of a work on orthopedic surgery, the difficulties I would have to meet: the vast orthopedic literature contains much that is uneven and obscure, so that it is often difficult to pick out what is correct. Still it is not possible to neglect entirely the description of older methods and apparatus, since, in individual cases, these may be of value; but modern orthopedics has progressed to such a degree, that I have felt obliged to consult many different and not easily accessible contributions, all the more since many of them did not originate in Germany and are therefore not within the reach of most practitioners.

Through a careful statement of the etiology and the pathological anatomy of the subjects with which we are concerned, I have endeavored to expose clearly the methods of treatment, and to simplify early diagnosis. In the choice of illustrations (and it seemed to me essential to select a large number) I have aimed at picturing the slighter as well as the more uncommon grades of deformities, and at representing apparatus of the most varied nature, which the physician must order even as he does the drugs in his recipe, that is to say he must give the mechanic explicit directions, and herein the illustrations will be of much service.

I trust that the following exposition of orthopedic practice and methods may excite the interest of physicians in this branch of medicine, for orthopedics may be looked upon as a step-child of the other medical branches, and I hope it may obtain for orthopedic methods more general recognition.

CHAPTER I.

GENERAL ORTHOPEDICS.

UNDER the term orthopedics (from ορθος, straight, and παιδεια, knowledge) we understand the subject of the deformities of the human body and the methods of prevention and of cure, and we see at once, therefore, that it is not separable from surgery, but must be considered an integral portion.

As in every other branch of medicine, so in orthopedics was the growth gradual up to the present stand-points; and in addition to marked advances (such as tenotomy, osteotomy, etc.) there have occurred many serious errors (such as the forcible straightening of the spinal column, the cutting of the muscles in the treatment of skoliosis, etc.). The opinions which have obtained have been in many respects opposed, and in regard to many points there has arisen great and protracted discussion. Bias and egotism have stood in the way of the recognition of some methods, or else a method has been open to the charge of charlatanism. At times, indeed, our chief aim, that of helping our patient, has been lost sight of amid these disputes. In these respects, our subject is darker and more forbidding than other branches of the medical science.

To sketch briefly the chief points in the history of orthopedics, we must, at the outset, state that its inception may be traced as far back as can human deformities; Hippocrates, Galen, Arabic physicians, Ambroise Paré, Severinus Arcæus, —these all have yielded us considerable information on this subject. Fabricius Hildatus reports, among other things, a case of severe contracture of the hand which he cured by suitable apparatus.

In the year 1500, Glisson first resorted to suspension in orthopedics; in 1685, J. Minius first performed tenotomy in case of caput obstipum, and certain physicians of Holland (Tulpius,

Mekren, Roonhuysen), described orthopedic results in their writings.

Andry (1741) first collected the observations of his predecessors, and gave the science the name it holds to-day. In 1780, A. Venel opened, in Switzerland, the first hospital for the treatment of deformities; in 1782, Lorenz, on the advice of Thilenius, first performed tenotomy of the tendo Achillis in a case of club-foot, but this fact was forgotten, and Delpech must be considered the man who first established orthopedics on a sound basis.

In 1803 Scarpa devised the since much-modified Scarpa club-foot shoe. Jörg (1806), Rudolphi (1832), Palletta, Soemmering, and others added much to orthopedics by their labors; but the science only made essential strides after L. Stromeyer substituted subcutaneous tenotomy for the early method practiced by Michaelis, Delpech, Dupuytren and others. With Stromeyer, Heine, Dieffenbach, Langenbeck, must be mentioned as men who furthered the advance of orthopedics.

Little, who himself suffered from club-foot and was operated upon by Stromeyer, spread the new methods in England, and sowed the seed for the founding of the Royal Orthopedic Hospital, in which, during its first ten years, not less than 12,000 patients were treated. The first fruits of this enormous series of observations was the work of Tamplin, and his colleagues, Lonsdale, Brodhurst, and Adams, made further advances in our subject in England.

In France, the names of Bouvier, Margolin, Pravaz, Guérin and others must be mentioned, and Bonnet and Malgaigne added as much to the knowledge of the diseases of the joints as they advanced orthopedics.

In America, orthopedic surgery was especially advanced by L. Rogers, Detmold, Mott, and the latter had schemed the foundation of the American Orthopedic Hospital, although his desire was not fulfilled till after his death.

With the increase in the number of orthopedic hospitals (and almost every large city to-day has one) the interest of physicians in the subject increases, and it is highly to be desired that the schools should give special instruction in this, the youngest of all the specialties, for thus the knowledge of matters which relate to orthopedics would be increased generally among the profession.

As in every branch of medicine, however, we cannot attain our aim without effort, for many individual methods endeavor to secure pre-eminence, as for instance the Swedish gymnastic cure, which originated with Ling (1776 to 1839) and has been extended by his pupils.

Others, on the contrary, seek to work solely through mechanical apparatus, and in some respects Langgaard was right when he said, "I believe that the claims advanced for gymnastics alone should not be deemed progress in orthopedics."

For a long while there was great discussion over the dynamic and the mechanical methods (Schreger, Heine, Werner), until each had been assigned its proper sphere. Finally, the essential foundations of orthopedics were laid by the anatomo-physiological mechanical studies of Weber, v. Meyer, Hencke, and especially after the appearance of the works of Hueter, Volkmann and others.

The endeavor to accomplish what is essential by means of simple bandages, etc., has especially led to important advances and to betterment in methods. Of greater importance than the improvement of mechanical apparatus, of more utility than the introduction of subcutaneous tenotomy (although since this time dates, in truth, a new era for orthopedics), has been the introduction of the antiseptic treatment of wounds, the great discovery of Lister. This has widened greatly the bounds of orthopedics, and since we have learned that we can, for instance, break a deformed bone without danger and cause it to heal straight, we have obtained the most brilliant results and cures in the shortest possible time.

Through these operative measures we are in a position to cure cases which, at an earlier date, no one thought of attempting to treat, in the presence of which, indeed, the physician was formerly powerless. We must here refer to a number of methods of great importance in orthopedics; namely, the extension method of treatment devised by Volkmann, which has quickly obtained acceptance, the use of elastic traction (Bruns, Barwell, Blanc, etc.), and, above all, the jacket method of treatment of disease of the vertebral column, for which we have chiefly to thank Sayre; all these methods are very valuable therapeutically, in the great majority of cases, and they must be looked upon as essential advances in the subject of which we are treating.

These advances have led to the rejection of many ancient objectionable orthopedic methods of treatment; and have caused orthopedics to be considered to-day an essential part of surgery, and even of an importance from a strictly medical standpoint, and we have only to glance over the records of the first, as well as of the smaller clinics, in order to see what a great rôle orthopedics play. Special courses in orthopedics are offered the young physicians in order that they may acquire the information which will afterward be so useful to them, and it is in this connection highly to be desired that each hospital (like the New York Orthopedic and others) should have a special work-shop, for the preparation of apparatus, in direct connection with it.[1]

In the past few years, particularly, there have appeared a number of noteworthy works on orthopedics. I need recall only those of v. Meyer, Lorenz, Vogt, Margary, Noble Smith, Kocher, Lücke, Mikulicz, Roser, Romanit, and others, which are mostly founded on pathological and anatomical researches as applied to new methods of treatment.

We may define the term deformity, in general, as being a morbid change of form of some part of the bony skeleton, or as a deviation from the recognized configuration of the symmetry of the human body (Tamplin); many orthopedic affections, however, as for instance anchylosis, depend on an abnormal alteration of function in a portion of the body (stiffness, limited mobility).

In the majority of orthopedic affections we deal with a curvature, that is, the form of the affected part is so changed that it deviates from the straight line, and it is chiefly in the joints rather than in the bones that the changes are found (the so-called loxarthroses).

In general, in orthopedics, we have to deal with diseases of the organs of locomotion, disturbances and diseases of the bony system, of the joints and ligaments, or of the muscles, and we may thence divide orthopedic affections according to the system chiefly involved, and we may further subdivide the subject according to the nature of the change in form, according to the causal factors. Above all, according to the time of occurrence, we may subdivide our subject into the two great classes of congenital and acquired deformities, as in the following scheme:

Congenital Deformities.	1. Malformations, primary errors in development: *a*, Primary error in the germ, defect in formation. *b*, Disturbances in development of the normally formed fœtus through loops in the umbilical cord, etc. 2. Intra-uterine deformities resulting from: *a*, Abnormal position of the fœtus in the uterus (congenital luxation, etc.). *b*, Abnormal intra-uterine pressure. 3. Deformities resulting from disease during intra-uterine life (rachitis, etc.), or injuries (fœtal fractures). 4. Deformities following on traumatism during labor.
Acquired Deformities.	1. Such as result from essential disease factors or traumatic influences: *a*, Unsuitable clothing (ill-fitting shoes), etc. *b*, Abnormal posture and what may be termed deformities resulting from occupation. 2. Such as result from disease: *a*, Of the bones (rachitis, tubercular osteitis, etc.). *b*, Of the joints, the cause of which is arthrogenous. 3. Such as result from disturbances in localities removed from the affected region: *a*, In the muscular system (myogenous cause). *b*, In the central or peripheral nervous system (neurogenous cause) 4. Such as result from traumatic influences: *a*, From changes in the soft parts (cicatricial contractions, etc.). *b*, From changes in the bones and joints (deformity from fractures or dislocations, etc.)

The question of the origin of fœtal deformities is still in many cases very obscure; often we must suppose an error in the germ, a *vitium primæ formationis*.

An hereditary influence will explain certain congenital deformities (such as congenital luxations, club-foot, etc.). Tamplin, for example, tells of a family where there were eight children suffering from similar bilateral club-foot. In other instances we are dealing with a primary disturbance in development resulting from a fœtal disease, where, for example, a part remains rudimentary, or may even be entirely lacking, and so in the course of the development of the other parts we witness deformity. A good example of this character is offered by curvature of the fore-arm or of the leg, which results

from lack of development of a bone and which leads to distortion of the hand or foot. Such cases have been described by Mosengeil,[2] Billroth,[3] and others.

Those cases are very obscure (although in some the data are authentic) where a sudden maternal impression during pregnancy (fright at the sight of a cripple, etc.) has caused the deformity of the fœtus.

FIG 1.—Curvature of the Radius; Luxation of the Head of the Radius with Defective Development of the Ulna. (Humphry.)

Instances of deformity are better explainable which may be traced to loops in the umbilical cord, or to abnormal posture *in utero*, which is offered as an explanation of talipes, and where, at times, a deficiency in liquor amnii is determined, leading to abnormal pressure on the misplaced part.

The etiology of deformities which result from intra-uterine disease or from traumatism suffered during pregnancy, is readily understood, although we cannot give absolute credence to all the recorded cases.

A fair percentage of deformities are caused by unfavorable, purely external causes; we will see how the carrying of infants on one side predisposes to skoliosis. Camper, Soemmering

FIG. 2.—Congenital Infraction and Curvature of the Fore-arm. (Munich Path. Institute.)

and others claim that the tight chest bandages have an unfavorable influence on the muscles of the chest. The modern, faulty method of shoeing children (pointed tips with high heels to the shoes) leads to characteristic deformities, such as hallux valgus, etc., and may cause serious trouble.

In the great group of deformities due to abnormal and constant pressure (genu valgum, flat-foot, etc.) a weakness of the muscular system is an efficient cause. The most impor-

tant factor here is the abnormal, constant malposition, under the influence of which there occurs unequal growth of the affected limb, in that at the points of pressure growth is interfered with, while at other parts growth is increased, and genu valgum offers a typical example of this. In this connection H. v. Meyer [4] differentiates a relative excessive strain (as in rachitis), and an absolute effect of external factors acting on the body.

Habitual methods of holding the body may lead to asymmetrical growth, to curvature approaching skoliosis, as witness the deformities in certain artisans, in watchmakers, in stone breakers, etc., and this is the more likely to occur when the cause acts early in life, before the bony structure has attained its growth.

More important still are the deformities resulting from disease of such a nature as causes softness and bending of the bones (rachitis, osteomalacia), or such as leads to disturbances of the bone tissue (tuberculosis, osteomyelitis,[5] and again, syphilitic osteitis, rheumatism). The arthrogenous deformities, those which follow on inflammation of the joints, are more infrequent the better such inflammation is treated. We deal here, generally, with the affection characteristic of each special joint, as we will note when speaking of contractures. Bone disease following on causes which check or interfere with growth, such as necrosis, may also lead to deformities.

Of no less importance in the etiology of deformities is the effect of diseases and their sequelæ. Thus, disease of a muscle may lead to diminished function, and as a result of excess of strength in the antagonistic muscles there may result deformity, or the same may follow on a lasting spasm or cicatricial contraction (the so-called myogenous deformities).

More frequently the cause of paralyses and spasms lies in disease of the central nervous system, and the great group of infantile paralyses is due to meningitis, etc., that is to say, to disease of the cord, of the brain and its membranes.

Deformities less frequently result from affections of the peripheral nervous system or from reflex effects from disease of the genital organs. Sayre reports a number of severe instances of muscular contractures due to phimosis, etc. The cause of these myo- and neuro-genous deformities is very variable according to the extent of the process.

In regard to muscle-antagonism, it was the belief that in all cases where the antagonistic group obtained the ascendency a nutritive shortening or deformity resulted from the contraction of the muscles and from the approximation of the insertion points. Hueter and Volkmann, however, have shown that we are rather dealing with mechanical influences, that is, with the weight of the affected section of joint, the habit in walking and in standing; that such influences favor the occurrence of paralytic deformities, and that much depends on the manner after which the affected joint is used.

A further influence (and Seligmuller, among others, has laid stress upon this) is the fact that the paralyzed muscles are not able to redress the position enforced upon a joint by the non-paralyzed muscles, and consequently each movement in the direction of the latter is effective, and the resulting provisional contracture merges, in the majority of cases, into a definitive.

Where all the muscles of a joint are paralyzed, the condition becomes that of a movable joint; when such a joint is used, the check influence of the muscles is lacking. The movements occur to such a degree as the approximation of the bone surfaces to one or another side, and as the tension of the ligaments allow, and since this tension will ultimately relax, the ligaments become stretched, and the bone surfaces suffer change in their configuration, and the deformity is magnified.

We will not consider further paralytic deformities, but will only note the fact that frequently a number of conjoined causes lead to deformity, that is to say, combined etiological factors are at work.

In the small group of congenital deformities which result from trauma, there belong those caused by injury suffered during labor (for example, torticollis, the rupture of muscles during rapid delivery, on which Stromeyer has laid stress).

Of the injuries to the soft parts which come under our observation, it is particularly the cicatrices following on burns and scalds, that is the contractures, which concern us, and these most frequently affect the hands and fingers. Deformities also result from injuries to the skin of the most different kinds, such as abscesses, etc., and these are of great importance when they cause separation of tendons or of muscles ; or when a motor nerve is involved and there ensues loss of its function.

We must mention further the deformities following on injuries to the bones. The most frequent are those which are the result of improperly treated fractures, also instances of fracture near the joints or inter-articular fractures, where proper manipulation or passive motion (massage) was not resorted to in time, or where a splint was worn too long.

The imperfectly reduced dislocations are infrequent sources of deformity, as is faulty union of fractures of the epiphyses.

The occurrence of deformity varies greatly, according to age and sex. The large proportion arise chiefly in childhood, and those due to external influences, as for instance, skoliosis, are met with chiefly in girls, while, on the other hand, those resulting from strain, such as genu valgum and pes valgus, occur with greater frequency in boys.

The symptoms of the deformity must naturally be specially treated, according to the demands of the individual contracture. As to the frequency of deformities, we need only recall the fact that Schrauth, in 1860, estimated the number in Bavaria as being 25,000. Werner claimed that there were 56,000 cases of skoliosis in Prussia, and he states that a census for England and Wales mentions no less than 409,207 deformed individuals, of which number one quarter, or 90,277, belonged to London alone. We see at once what a burden these deformed individuals are to the state, for it is not possible, as Dieffenbach[6] suggested, to utilize the club-footed as cavalry men. Many orthopedic diseases, further, render the sufferers partially or totally incapable of work, and unfortunately, the majority belong to the poorer classes. The deformity, again, reacts markedly on the individual himself. The state of the general health often suffers from direct implication of internal organs (as in aggravated skoliosis and kyphosis), and in instances of exaggerated talipes, etc., from lack of exercise in the open air. Further still, we must note the depressing effect of the deformity on the mind, a circumstance to which Tamplin[7] has well given expression. Indeed, in how many cripples is not the pyschical pain apparent in the physiognomy? Poor and rich, high and low, stand on an equality in this respect. How much pain did not Lord Byron's club-foot cause him! That master in depicting human feelings (Shakespeare) expresses this, among other places, in the opening monologue of Gloster's in Richard III.:

"But I,—that am not shaped for sportive tricks,
Nor made to court an amorous looking-glass;
I, that am rudely stamp'd, and want love's majesty,
To strut before a wanton ambling nymph;
I, that am curtail'd of this fair proportion,
Cheated of feature by dissembling nature,
Deform'd, unfinish'd, sent before my time
Into this breathing world, scarce half made up,
And that so lamely and unfashionable
That dogs bark at me as I halt by them."

On the other hand, it is well known that the intellectual faculties are apt to be highly developed, and many a distinguished man has been more or less deformed (Socrates, Æsop, Alexander the Great, whose head is said to have been turned toward the left, Burleigh, Pope, Talleyrand, Flaxman, Byron, Mendelssohn, etc.). Little was operated on by Stromeyer for club-foot.

In regard to the diagnosis in general, of deformity, in the vast majority of cases simple inspection proves its existence. Still it must not be taken for granted that the variety of deformity always suggests itself; at the very beginning, when correct treatment is of the greatest importance, this is not the case, and we often must recognize a slight deviation from the normal, a minor projection, etc., and often the position assumed by the patient suggests this, as for instance, the forward curve when the arms are raised, in case of skoliosis.

Occasionally, orthopedic affections only cause functional disturbances, and in these instances examination under anesthesia often first teaches us the degree of the diminished mobility, etc., as, for instance, in case of contractures.

It is highly important in many cases, for comparative purposes, to carefully measure the deformity and to make a schematic drawing of it.

The ordinary tape-measure answers the first indication, and the second is fulfilled by the plaster cast, by photography, by the direct tracing of the contours.

In case of many deformities it suffices to measure the angle which the joint abnormally forms, and for this purpose, in addition to the ordinary square, the goniometers are useful. I may mention the goniometer of Morisani,[8] Krohne, Paci,[9] Gutsch.[10] I will only figure the Roberts' instrument.

In many cases it is essential to take the measurements at

different levels (the sagittal, vertical, and frontal), and for this purpose complicated instruments are necessary. Among others Roberts [11] has made use of geometry for the description of deformities, terming the method *diastrophometry.* A number of useful instruments have been devised for the purpose of measurement.

In Roberts' Goniometer (Fig. 3) both arms may be used and made so short that the angle of a kyphosis may be determined. Pelvic obliquity, abduction or adduction, flexion or ex-

Fig. 3.—Roberts' Goniometer.

tension, in short any deformity at any level may be measured by this instrument.

For the determination of deformities at different levels Robert's epipedometer (Fig. 4), which may be placed at any angle, is useful.

The two arms of the instrument, at right angles to one another, may be fitted to any surface of the body, and the deviations of the arms are carefully registered in degrees; one arm may readily be shortened, so that the instrument is also of utility in the measurement of club-foot.

Instruments of this nature are especially applicable to skoliosis, and many are nowadays constructed.

To obtain the configuration at any level an ordinary strip of lead will suffice. The lead-curve thus obtained may be transferred to paper.

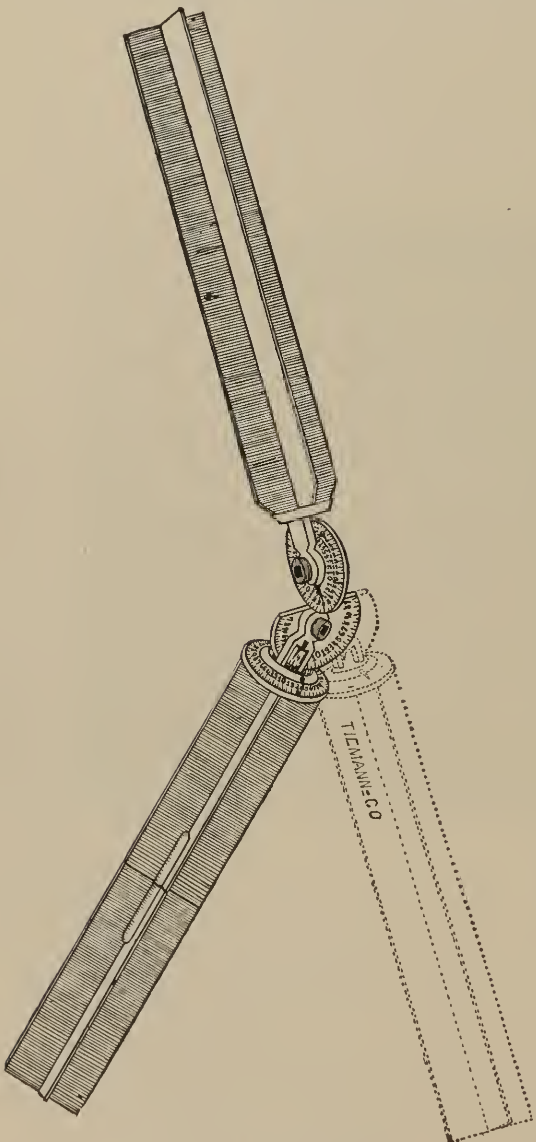


FIG. 4.—Roberts' Epipedometer.

To measure the thorax the kyrtometer is useful, as also analogous instruments constructed like hat machines. To register simple cross-sections, the apparatus of Stark[12] (a double-circle with pencils at each extremity), that of Schenk and others may be resorted to. In many instances of deformity of the foot it is advisable to obtain an outline of the plantar surface a pelmatogram (πελμα, sole). The patient is made to tread with blackened foot on a sheet of paper and thus a picture of the sole is obtained; the patient can be caused to walk on the paper and thus

his manner of placing his foot down when walking is obtained (an ichnogram or stibogram). The value of this method has been particularly emphasized by F. L. Neugebauer,[13] Vierordt and others.

The prognosis of deformities, in general, may be considered good when no severe general disease is at the bottom, and when we are not dealing with a defect in formation of the bony parts, as in skoliosis. By means of bandages and apparatus, and particularly by the modern operations, the surgeon is able to obtain complete cure, or essential betterment, in a relatively large number of cases. Even in case of curvatures not specially accessible to therapeutic methods, such as skoliosis, the prognosis has become much more favorable when the cases come early under treatment, for then we frequently obtain betterment, or at least check the progress of the affection.

We would note specially here that only in case of a few deformities does spontaneous cure occur, as in the slighter degree of rachitic curvatures; in by far the larger majority of instances, the deformities are progressive, and it is a mistake to tell the relatives that in the course of growth the deformity will alter for the better, for thus the most profitable time for treatment is allowed to pass.

In connection with therapeusis we must lay stress on prophylaxis, the entire aim being to cause the body and brain to develop simultaneously, to further by all means the *mens sana in corpore sano*. Under this head are included not alone the proper food and clothing in childhood, in brief, attention to every detail of hygiene, but also suitable hardening of the bony and of the muscular system. Gymnastics, swimming, riding, out-door exercise and work, etc., these may do much to prevent the development of many deformities. In how far this bodily exercise may favorably affect the race, ancient Greece with her Olympic games is a witness, and I recommend, in particular, gymnastics after Busch's[14] description.

In this connection it is a cause of congratulation that the chief sports in England (ball playing, rowing, etc.) are obtaining a greater foothold with us. Another important factor for the prevention of deformities lies in the spreading of the knowledge of how to treat diseases of the joints properly. It is essential that the inflamed joint should be placed in such a

position that, if anchylosis ensue, it may be most useful (that is, hip and knee well straightened out, foot and elbow bent at right angles); further, it is important to resort in time to passive motion, manipulations and massage, as soon as the essential inflammatory symptoms have disappeared.

Most frequently it is the congenital deformities which reach a high grade, since the parents of the sufferer, from stupidity or ignorance, do not seek the requisite treatment early, and herein lies the great value of state institutions such as Stromeyer and Dieffenbach argued for and Lorenz has latterly recommended. "What good end would not a state institution fulfill where all the crippled children of the land could resort, and if possible be cured,—" thus speaks Lorenz, and indeed such institutions would be of far greater value than the offering for sale of faulty orthopedic apparatus.

As regards the appropriate treatment of deformities, we may in general range ourselves on Seneca's side when he says: "Sanabilimus ægrotomas malis ipsaque nos in rectum genitos natura si emendari velimus, juvat," the majority of orthopedic troubles being curable or subject to betterment, and in many cases by means of the simplest appliances.

No single scheme of treatment, however, is applicable here, no single method but a combination of many methods usually fulfills our aim; we must not alone depend on mechanical means but also resort to dynamic, and among the former must be classed gymnastics, "orthopedic-gymnastics," as Delpech termed them.

In orthopedics we must, in particular, individualize, for each case has its own special indications which must be attended to; a method which in one case seems suitable, in another will not be appropriate. In any event, the general state of the patient must be considered.

To mention now the most essential orthopedic methods of treatment, we have: 1. The constitutional, general treatment, which includes: *a.* Attention to hygiene; *b.* Medicinal agents; *c.* Physical agents (gymnastics, massage, heat, etc.); *d.* Electricity.

2. Mechanical agents (bandages, orthopedic apparatus); and finally,

3. Orthopedic operations (either requiring the knife or not).

The error was formerly made of considering the constitu-

tional treatment the chief one, and to-day actually this principle obtains to far too great a degree. There can be no question that attention to the general rules of health, the obtaining of fresh air, care of the skin by baths, etc., strengthening food (breast milk for young infants), will effect much, and that in orthopedic hospitals the good results obtained are in part to be laid to the application of hygienic principles; still these health-rules will not alone suffice, except in very rare cases where they are associated with the strengthening action of sea air, as at the sanitariums at Norderney, Sylt, Margate, Ramsgate, Eastbourne, Bec-sur-mer, Trouville, etc. Of medicinal agents of value the chief are iron, preparations of quinine, cod-liver oil. In rachitis the phosphates and sulphates are especially useful at an early stage to replace the lack of bone salts. To-day, owing to the researches of Kassowitz and of Wegner,[15] we must grant considerable value to phosphorus in the treatment of rachitis.

In case of 500 rachitic children Kassowitz witnessed the most marked results from the administration of phosphorus, and Unruh, Th. Toeplitz[16] and others have confirmed these results. Kassowitz recommends a daily dose of $\frac{1}{13}$ of a grain in mucilage or in cod-liver oil.

℞ Ol. Morrhuæ, ... ℥ iij ʒ ijss.
Phosphor., ... gr. $\frac{1}{65}$.

Or in an emulsion as follows:

℞ Phosphor., ... gr. $\frac{1}{65}$.
Solve in Ol. Amygd. dulc. ʒ ijss et adde
Pulv. acaceæ,
Syr. simpl., ... āā ʒ j gr. xv.
Aq. destil., ... ℥ ij ʒ v.
M. S.—One to four teaspoonfuls daily.

Latterly, Lesser has recommended the following as an antirachitic mixture:

℞ Tr. rhei vinos., ... 20 parts.
Potass. acet. sol., ... 10 "
Vini stibiat., ... 5 "

M. S.—According to the age of the child administer from five to ten drops three times daily. Increase the dose every third day by one drop until the child receives from twenty-five to thirty drops three times daily.

In addition to the above remedies, in cases of paralysis, strychnia may be ordered in the dose of $\frac{1}{65}$ of a grain three times each day, or else it may be administered subcutaneously in the dose of $\frac{1}{20}$ of a grain once a week, this dose being increased according to circumstances.

Of the general physical therapeutic agents, we note: heat in the form of the sun-baths, warm baths and douches, the use of the vapor bath to equalize the circulation. In paralytic cases and in chronic joint affections, the peat and salt baths, dry heat as recommended by Beard, of New York, may be used and the latter may be applied by means of Leiter's coil. Hot poultices, protected by gutta-percha paper, will often be found useful.

A method which has been enthusiastically claimed as the only true and efficient one in orthopedics and again has been rejected as simple humbug, is gymnastics, that is to say the methodical exercise, active and passive, of the muscles. There is no question that this method, carefully and continuously

Fig. 5.

used, aside from its general strengthening effect, is valuable in the treatment of many orthopedic affections, especially where we aim at exciting and restoring function in certain groups of muscles. Of special value is the method devised by the Swede, P. H. Ling (died in 1839), and amplified by a number of others (Bronting, Rottstein, Norman Roth,[17] etc.), the method of so-called "Swedish gymnastics," whereby not only active and passive movements are utilized but also a general effect on the muscle functions is exerted. This method has many adherents, and it is applied in a number of institutions, such as those at London, Stockholm, Baden-Baden, etc.

The most essential point about the Swedish gymnastics is the methodical movements to which the individual is subjected. Either the operator endeavors to overcome opposition on the part of the patient, or the latter on the part of the former.

Apparatus for these passive movements may also be used.[18] Especially useful are the so-called thoracic joint-strengtheners (Largiadèr[19]), the restorator (Goodyear), which is seen in Figure 5.

The restorator[20] is especially useful for the methodical exercise of muscles, for owing to the necessity of stretching the rubber band, the patient may himself take account of his muscular power (Vogt, Weil[21]). The same is true of other apparatus, such as those devised by Sachs, by Seeger, and others.

Massage (from μασσειν, to rub) was used by the ancients, the Indians and other races,[22] for therapeutic purposes; its utility has lately been exposed by Metzger (Amsterdam), Mosengeil, and others, and the results obtained have led to its wide dissemination.

Massage consists in rubbing, pressing, striking, etc., a portion of the body. It increases the force of the circulation, it causes a more rapid absorption of the products of inflammation; under the influence of massage partial stiffness of joints disappears, atrophic muscles become richer in blood and stronger, in short the nutrition is improved, and the retrogressive phenomena occur to better advantage in the parts subjected to the manipulation. In particular has Mosengeil[23] utilized the various manipulations (*effleurage* or centripetal stroking by flat hands, frictions, ellipsoid rubbings with the finger tips, *pétrissage* or kneading of the affected part, *tapottement*). These various manipulations have become popular, and latterly, works on massage have appeared in which the technique is carefully described,[24] and instruments have been devised to take the place of the masseur's hands (such as the elastic muscle-beater of Klemm, or that devised by Flasher[25] which is constructed of wood).

The effect of these methods is due rather to the rubbing than to the materials which are rubbed in, such as vaseline, borax ointment, olive oil.

In this connection we must refer also to passive movements, the so-called manipulations, the rotatory motions in the direction opposed to the deformity, which are applicable especially to club-foot, being repeated frequently during the day, the foot being redressed and held in such position for awhile in a suitable apparatus.

In this way the ligaments and bones are prevented from developing abnormally, for the deformity increases with growth, and thus the obstacles to redressement are lessened without the motion of the affected part suffering. Generally, other methods, such as holding the affected part for a long

time in as good a position as is possible, will effectually assist.

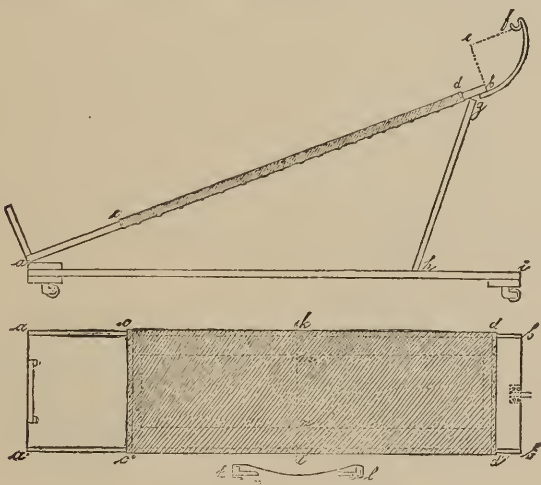
As regards the applications of electricity in orthopedics, the faradic, and more frequently the constant, current may be used over single muscle groups, but the current must not be too strong, or of too protracted duration (five to fifteen minutes once or twice daily). Sayre lays stress on the point that, when a paralyzed muscle is galvanized, it must be placed in such a position as to be subject to no strain of any kind whatsoever.

The action of the current is all the stronger when it is applied to the spot where the most effective motor branch enters the muscle. Duchenne, of Boulogne, and v. Ziemssen [26] have considered at length the preferable points of application, and for such information I must refer to their valuable works.

In exceptional cases galvano-puncture of the muscles will prove effective, that is to say, the passage of the current through the muscle, by means of a needle connected with an electrode and inserted into the muscle while the other electrode is placed on the surface of the skin.

We now pass to the description of the simplest mechanical appliances, the position and fixation apparatus. The former plays an important rôle, especially in the treatment of disease of the spinal column, and it may answer the purpose of affording rest to the entire body, or else of only a portion of the body (as for instance Eulenburg's [27] scoliosis apparatus, and the devices of Bonnet, Mayer, Rauchfuss, and others). For the sitting posture, the Volkmann-Barwell's oblique seat is to be commended (for skoliosis). We may mention here, also, the numerous orthopedic beds, as those of Valerius Venel, Guérin, Bouvier, Pravaz, Boynton, Harrison, Heine, etc. The majority of these beds are supplied with extension and counter-extension mechanism. Such apparatus will be spoken of under the heading of mechanism for reduction. As an example, we will describe here the Beely extension bed for skoliosis, which is seen in profile in Figures 6 and 7. *hg* answers the purpose of elevation to the desired extent; *bf* is for the attachment of the girdle; *f* is a roller over which the weight is suspended; *cd* is the linen covering of the surface *ad*. In Fig. 8 the girdles are seen which pass under the chin, back of the neck and under the axillæ.

Other beds are provided with mechanism for lateral inclination, such as Delpech's, H. Bigg's, and girdles may also be fitted to them. In the Bürings [28] apparatus for skoliosis, pads worked by screws assist in reduction. The same holds true of



FIGS. 6 and 7.—The Beely Bed.

Hüter's modification of this apparatus, and of Loring's, which is used in hip contractures, etc.

I can all the more readily pass over these apparatuses since most of them are only of historical interest and have latterly been described by E. Fischer,[29] and I may dismiss from consideration the orthopedic chairs, etc., for they are no longer in use.

I will mention the so-called mechanical beds and the beds fitted with apparatus for lifting the patient. The first allow of defecation and of change of the bed-clothing without specially disturbing the patient, and this is accomplished either by sliding a board with an opening in it under the patient, as in the R. Volkmann bed,[30] or by an extension mechanism,[31] as in the Lücke bed; or further still by mechanism by means of which the mattress sinks down and may be removed, as in the Crosby bed. Of the

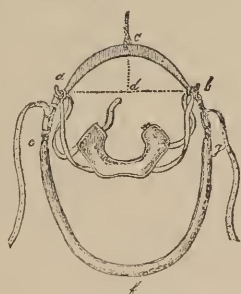


FIG. 8.—Girdle of Beely's Bed.

apparatus for lifting the patient, the best is Beck's, since it is contrived so that the whole body of the patient or an individual portion, may be lifted.

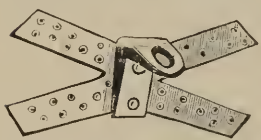


Fig. 9.—Hook for Insertion in a Plaster of Paris Bandage.

We pass now to the consideration of the various orthopedic bandages which are intended, usually, to maintain a deformed portion of the body in position and thereby lead to better appearance, or possibly, only to betterment in function. The importance of these bandages is all the greater, seeing that by means of them we can, in the cheapest and quickest manner, apply suitable treatment, and

Fig. 10 a.—Roberts' Elastic Tension Corset with Jury-mast.

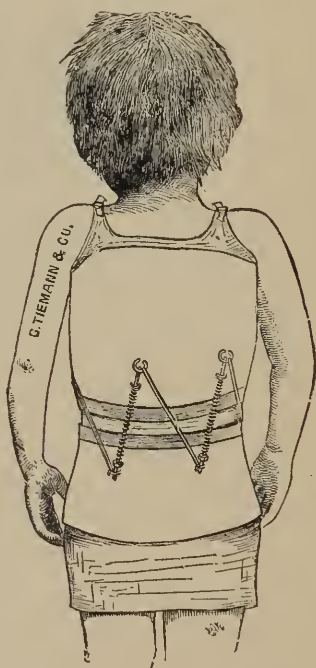


Fig. 10 b.—Roberts' Plaster Bandage with Extension and Elastic Traction Apparatus.

in that the physician may combine with them a number of other adjuvant therapeutic means (such as extension, elastic traction, pressure, etc.). They are generally useful, in par-

ticular in dispensary practice, where they most frequently answer the indications.

The plaster bandage with justice leads the others, and it is best prepared from large-meshed gauze rubbed in finely pulverized modeller's plaster. The plaster, when it has hardened, answers the purpose of holding the bandage in place. To strengthen it in various places it is advisable to fit in here and there pieces of wire or corset-steels, etc., or pieces of linen dipped in plaster may be inserted in the bandage as it is being applied.

It is often essential in laying the bandage to insert splints to maintain redressement, and these keep the parts in position during the setting of the bandage.

In children it is advisable to varnish the bandage after it has hardened to prevent its becoming wet through by urine, etc.

By sinking hooks or brackets into the plaster we obtain points for attachment of extension or traction apparatus, as is seen in Heine's[32] extension-splint. In Fig. 11 a simple apparatus of this nature, made by Reynders, is seen. The arm *D* is moved by the long screw *C* by means of the key *G* and is fastened at *E*. The ends are inserted into zinc plates which are fitted into the plaster bandage. The splints of this nature devised by Beely,[33] of the Königsberg Clinic, are especially useful in orthopedics, particularly where the lower extremities are concerned.

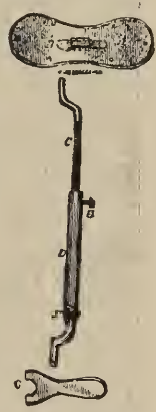


Fig. 11.—Extension Splint.

We may note here the Robert's plaster corset with extension blades sunk in, the length and force of which are regulated by the screws.

The bandage made from plaster with the addition of coal dust has the advantage of being lighter, of setting more quickly, and of resisting moisture better, and was recommended by the workers in Langenbeck's clinic. The paraffine bandage has been warmly indorsed by many, Whitson for example, owing to the lesser danger of decubitus resulting.

The silicate of soda bandage has, in general, the advantage of lasting longer and being less heavy, but its disadvantage is the fact that it requires more time for hardening; in ortho-

pedics, still, it is advantageously used for making corsets,[34] etc., but the precaution must be taken not to moisten the first turns of the bandage too thoroughly, else the lower surface will become impregnated and be rough.

In order to overcome the objection to the silicate bandage that it requires too long an interval for hardening, an oiled-paper may be laid over it, and next a few plaster layers which may be removed in a few days after the silicate has hardened. (Wolff, Fowler, etc.) The silicate bandage is as appropriate for the lower extremities as for spinal corsets. König uses, with good result, a mixture of magnesite and silicate of soda; such bandages are readily worn and are not likely to be broken or wet through.

FIG. 12.—Orthopedic Plastic Felt Apparatus. (Beely.)

Paste-board bandages are also used, and are recommended especially on account of their slight weight, and they may be made very solid and lasting by the insertion of splints, etc.

Plastic felt impregnated with hair (presented by Cocking in 1870, and first used by Ernest Adams) has quickly obtained a foothold in orthopedic surgery. It may be readily shaped by dipping in hot water; Beely[35] has used it after impregnation with an alcoholic solution of shellac. It may be modelled over a plaster cast of the part where it is to be applied, and it may be loosened or tightened, according to desire, when in place (Schwartz[36]).

We will now speak of the methods of preparing casts from plaster of Paris over which the plastic felt may be modelled. Over the oiled surface Beely places a plain, lightly applied, plaster bandage, and this is cut and removed as soon as it has hardened. The interior of this cast may then be filled with plaster and the desired model is obtained. That the model

may not be too heavy a tube may be inserted through the centre.

For the preparation of casts of the back certain modifications have been introduced. Braatz[37] makes a light cast by covering the inner surface of a linen model with an inch or so of plaster; after the removal of the covering the plaster cast is smoothed down and the felt is fitted over it.

Karewski[38] quickly lays a plaster bandage around the sus-

FIG. 13 a.—Patient before Adaptation of Corset.

FIG. 13 b.—The Corset with Suspension Bands.

FIG. 13 c.—Patient Suspended with Corset in Place, prepared for Covering with Plaster.

pended patient, inserts the hooks while the plaster is soft, cuts the corset when the plaster has hardened, smooths the edges, and then oils the model and rubs plaster over it.

In Figs. 13, a, b, and c is represented Heidenrick's[39] method of obtaining a cast. He suspends the patient and places around him a sack made of coarse linen, brought together above with a running string, packed with cotton below and made fast above the trochanters. On each side of the oiled

body extending over the shoulders is a string which serves the purpose of cutting the plaster cast, before it has hardened too much, into two pieces exactly adapted to one another.

In Fig. 12 Beely's [40] method of using felt is shown.

Leather has also been utilized for corsets, etc., and owing to its durability and elegance its application is a wide one, Beely used stout leather hardened in glue, and by painting it over with double potassio-chromic acid he makes it very resistant to moisture. Karewski [41] and I. Smith recommended fine wire gauze for orthopedic bandages, and this has the advantage of being light and permeable to the air. In exceptional cases hard rubber, softened in hot water, will prove useful; when heated it may be readily bent to any desired shape and retains it when hard.

Another material often used in orthopedic surgery is diachylon plaster, and this leads us to speak of the traction bandages which are resorted to to prevent contractures, to assist growth in a desired direction, etc.

This plaster is most frequently used for the redressement of slight deformities of the feet, etc., generally in connection with splints, etc., and for orthopedic purposes it must, of course, be not too yielding, and be possessed of good adhesive properties. Maw's moleskin plaster is a good article. Before the application of the plaster the surface must be washed off with soap and thoroughly dried. If necessary it must be shaved. In case of extension bandages, which are chiefly used for the lower extremities, the Volkmann method of plaster and footpiece has obtained wide acceptance. In addition to the quality of the plaster, care must be taken to pad the tibia and the projecting bones of the ankle, lest decubitus ensue.

In the majority of cases, extension may be obtained by stones or sand-bags slung over a roller, while the counter-extension is yielded by the weight of the body. Rarely are inclined planes requisite for counter-extension.

When extension is made from the head, it is obtained by leather bands (*a* and *b*) encircling the chin and occiput, which are united each side under the ears by buckles (*c*), and are suspended from above by slings attached to rings (*vide* Figs. 14 and 15).

A simpler method is, after shaving the head, to use strips of plaster under the chin and occiput, extending them over the

ears to the level of a tangent across the sinciput and here to attach them to a hook by means of a third sling of plaster.

To obtain horizontal extension there are a number of appliances applicable to skoliosis, torticollis, etc., which will be spoken of under the subject of curvature of the spine.

We find the principle of vertical extension in ancient orthopedic apparatus, such as the Bloemer chairs, the Shaw sling, and these are not only useful in case of disease of the spinal column, torticollis, etc., but also in cases of curvature of the limbs.[42] Thus, the vertical apparatus recommended by Schede and others, for fracture of the thigh in children, may be utilized in case of aggravated rachitic curvature of the femur.

In simple suspension, that is to say in the lifting of the body from the sitting or standing posture (as may be accomplished by Glisson's slings, axilla slings, Beely's self-suspension apparatus, Fig. 16,) Sayre's tripod, which may readily be

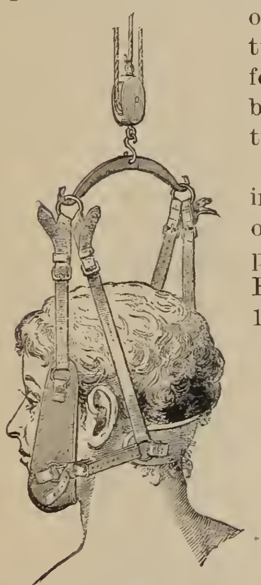


FIG. 14.—Head-Sling (Beely.)

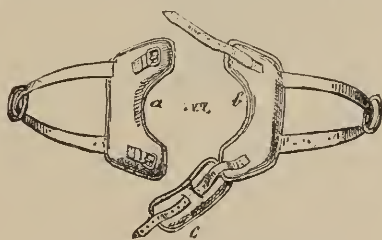


FIG. 15.—Head-Girdle in two parts.

improvised, is useful. The body-weight acts as counter-extension; occasionally we may, in addition, obtain a species of lever effect by causing the patient to bend over a line (Vogt[43]).

Orthopedic apparatus should not only be cheap, lasting, and readily applied, but in the majority of cases it should be carefully supervised. As Noble Smith says, "No instrument will be of much use unless the surgeon devote his attention to its adjustment and re-adjustment"; and as Hennequin[44] says, "Un appareil quelqu'il soit ne vaut que par celui qui l'applique." It is not so much the apparatus as the manner of

its application which makes it efficient, and badly applied it will work harm.

As to orthopedic apparatus in general the simplest is the best.[45] In many cases, where formerly apparatus was necessary, we can to-day dispense with it in favor of operative procedures, etc. Much always depends on the exact application of apparatus, and this is the reason why the aid of an expert orthopedist must, in special cases, be invoked.

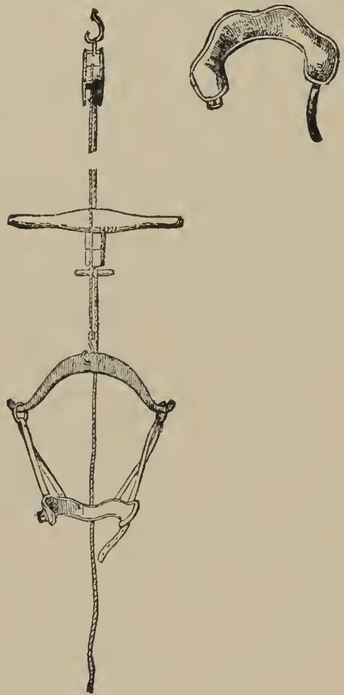


Fig. 16.—Beely's Apparatus for Self-suspension.

Fig. 17.—Suspension Apparatus.

We may divide the apparatus into: 1. Retention means; 2. Reduction means, by which curved or deformed parts are restored to the normal position by traction or pressure; 3. Ambulant apparatus.

In general, orthopedic apparatus may be divided into ambulant, that is, that which may be worn by the patient while about, and into apparatus which can only be used with the patient in bed.

The materials out of which the apparatus may be constructed are steel, iron, wood, leather, hard rubber combined with elastic straps, etc. The most durable and elegant splints are those constructed of leather fashioned over wood or plaster models, connected together by steel blades and straps, and with movable joints. These are light, and therefore particularly advantageous when, as in case of paralyses, etc., they must be worn for a long time. In regard to the nature of the joints, the hinge, as we find it in any pocket-knife, is the most frequently resorted to. Less frequently the joint is constructed similarly to the hinge of a door, the motion being at the level of the surface of the splint (as in Bonnet's apparatus for the prevention of inward rotation of the foot, where the pelvic gir-

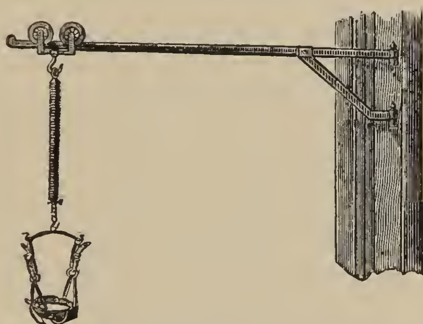


FIG 18.—Extension Projection of Iron Fastened to a Door. The suspension portion moves on rollers.

dle and the splint for the upper leg are so connected. This is shown in Fig. 29).

Where it is essential to obtain motion in a number of directions, a variety of joints are combined. By the combination of three, Stillman, for instance, has devised a universal joint, thus obtaining all the advantages of the ball and socket joint (free motion in all directions), without the disadvantage of being obliged to entirely fix the joint or else to allow of motion in any direction.

The enarthrosis, or ball and socket joint, is less frequently used, as it is found in certain apparatus devised for torticollis (Bruns), in a number of club-footed appliances (Busch), in apparatus for congenital luxation of the hips (Nyrop), etc.

The joints are rarely entirely uncontrolled, for they are in-

tended to guide, as it were, the movements of the part of the body concerned, to control the motion of the limb in a certain direction; in the knee, for instance, to prevent lateral movements; usually the object is to allow motion only to a certain degree, or to prevent motion in a special direction.

With this end in view counter-checks are inserted in the joints to prevent undue movement in the direction opposite to that which is desired.

On the other hand, it is often essential to prevent motion only to a certain degree for a special purpose, that is to say, to be able to limit motion, and for this purpose screws answer best. By means of screws the two sections of the apparatus may be joined together at any desired angle.

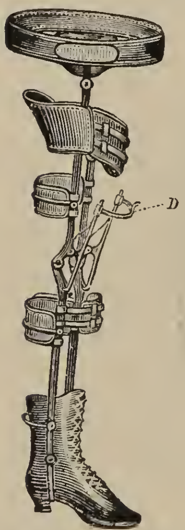


FIG. 19.—Nyrop's Machine for Paralysis of the Lower Extremity.

A very practical application of this point we find in the Stillman sector splint among others, where one splint may be placed at any angle to the other and is held in position by a screw.

Where the aim is to secure position in a special direction, as in extension, then a simple bracket or bolt-like mechanism is the readiest, as is exemplified in the apparatus for keeping the knee extended, where a small steel arm, projecting from one splint, fits into a circular piece on the other splint.

Fastening may be accomplished in a very simple manner by means of clasps, fitting the one into the other, attached to the sections of the splint—as in the Nyrop apparatus for paralysis of the extremities, a contrivance which is all the more valuable practically in that by slight pressure on a circle (*D* in Fig. 19) the apparatus may be quickly set out of function.

Where fixation in very different directions is essential, we may insert a small spring which fits into a toothed wheel, as in the Baedenheuer shoe for club-foot, etc.

In the ambulant apparatus for the lower extremities, the mechanism is ordinarily fitted into the shoe, the two blades of the splint being united between the inner and outer sole of the shoe, or, in order to be able to separate the blades, they are

inserted into projections at right angles to the shoe or firmly bound to them by a clasp spring.

Where we are not obliged to take the question of cost into consideration, it is preferable, from the stand-point of durability of the apparatus, to fit a well-padded metal sole on the shoe, so that the apparatus may be worn independently of the shoe, that is even with slippers.

The orthopedic shoe is of special importance. Often, by making the sole of one shoe higher than that of the other, or by the addition of an extra section of leather to the sole, we may counteract an abnormal position of the foot, or by building up one side of the shoe we may oppose a curvature. These points are exemplified in the Kolbe club-foot shoe, and in others. By a very simple contrivance the patient can be compelled to place his foot down in a special manner, as is exemplified in the mechanism in the Roser stirrup shoe, where a metal stirrup projects laterally from the surface of the shoe. Occasionally a rubber sole is to be commended, owing to its durability and pliability, the latter quality allowing any desired shape.

In order to make locomotion easy and in order to secure certainty of adaptability of the foot to the shoe, it is advisable to have it laced all the way up in front above the ankle joint. Thus the foot is thoroughly secured.

A large majority of the ambulant apparatuses are attached at the pelvis and for this purpose a well-padded girdle is necessary. This may be made of sheet iron and in front of leather. In many instruments steel bands, padded, pass over the crests (Langgaard) and are attached to the pelvic band.

Where it is particularly desired to fix the apparatus to the pelvis we may use corsets, as is the case in various French appliances. These may surround the hips, sacrum, or the entire lower abdomen and back, and the special apparatus may be attached to the corset by steel clasps or by leather straps. Again, as in the Nyrop corset for inferior lumbar kyphosis, a pad may be placed over the nates behind the trochanters and be attached to the corset.

Further, dorsal splints, with head supports, etc., may be adapted to the pelvic bands and these may be fitted into an orthopedic corset.

Other important orthopedic apparatus is seen in the reduc-

tion machines, which we may divide into ambulant and non-ambulant, and in the construction of which we find the most varied mechanism. In case of the non-ambulant apparatus, we deal with extension mechanism by weight, bands, etc., either in one direction—as in Stromeyer's equinus apparatus (Fig. 20), the Lorinser-Bonnet knee contracture apparatus—or in two opposed directions, as in various extension beds (Heather Bigg's, Fig. 23, Heine's, and others) which will be spoken of in detail under the subject of diseases of the spinal column.

The ambulant apparatus is to-day used with far greater frequency, and here the principle of the lever (one-armed or two-armed) may be utilized, as in the apparatus adapted to

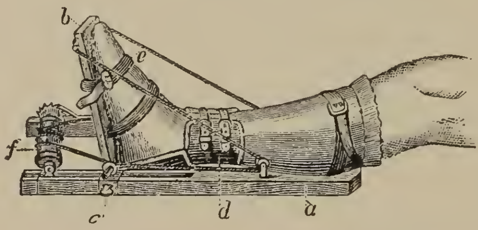


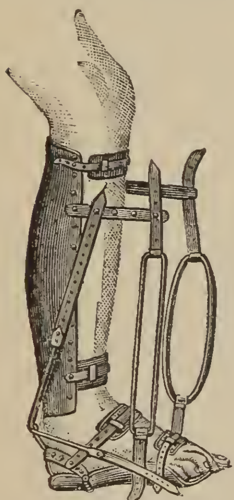
Fig. 20.—Stromeyer's Equinus Apparatus.

genu valgum, contractures, club-foot, etc., in the shape of different lever splints.

A very efficient means of reduction is offered by elastic traction, whereby we may obtain a continuous, slight, graduated force, or, if desired, a very great force (Barwell, Bruns), and we may use for this purpose either material with rubber set in (as in the Barwell skoliosis bandage, the Fischer bandage for skoliosis), or else rubber bands (as in the various contracture apparatus), or rubber rings which are placed between two straps, and the force exerted by which we may graduate by means of the straps. Elastic traction is exerted in many of the recently devised orthopedic appliances, such as the ingenious apparatus of Blanc, the club-foot apparatus of Sayre, Stillman, and others, and this traction is all the more to be recommended since it may readily be combined with plaster-bandages, or any material which it is desired to use. Thus, elastic traction is resorted to in rotation of the foot, by connecting the lateral bars of the splint with elastic bands (Beely).

Among these appliances with elastic traction are included those where groups of muscles are re-enforced by the tension in order to antagonize other groups. Delacroix, Duchenne and others have commended such appliances, of which number we will only refer here to Delacroix's apparatus for paralysis of the extensors of the fingers, and to the apparatus for use in paralytic pes equinus and pes calcaneus, where the paralyzed muscles are re-enforced by elastic bands or rings.

Spiral metallic springs may also be used for traction purposes, as is exemplified in Heather Bigg's extension bed (Fig.



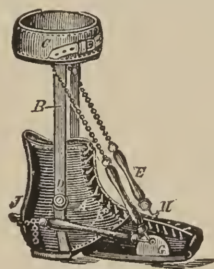


Fig. 22.—Sayre's Shoe.

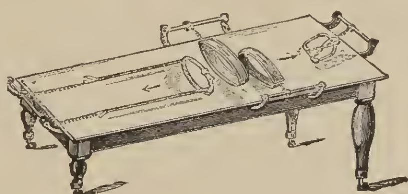


Fig. 21.—Lücke's Apparatus for Club-foot.

Fig. 23.—Bigg's Extension Bed.

23), and the spring may also be utilized for obtaining rotation, as in Doyle's apparatus for the after treatment of club-foot.

In case of paralysis, these spiral springs are also resorted to, as in Mathieu's apparatus for paralysis of the quadriceps femoris, where the thigh and the leg splints are connected together in front by a spiral spring. Springs are also adapted to many appliances for pes equinus, pes calcaneus, and to Duchenne's apparatus for paralysis of the muscles of the foot, where small springs, corresponding to the paralyzed muscles, are inserted into the leather.

These springs are also useful to keep two portions of a bandage apart and to obtain extension, as in the Roberts corset (Figs. 10, 25.).

In spring steel splints we also have a valuable means of reduction, and they may be used either to exert traction or pressure. In the first instance, they may be parabolic in shape or S-shaped. These springs are used in the numerous club-foot shoes (as in Scarpa's shoe and its many modifications), the band fastened to the leg keeping the foot pronated and abducted. The S-shaped band exerts not only extension but also sub-luxation backward, as is exemplified in many pes equinus, and in many contracture appliances (Heather Bigg's knee apparatus, for instance).

Resort to metal bands for the purpose of exerting pressure we see in connection with pressure cushions, and Nyrop's skoliosis apparatus may be taken as the type. In this apparatus the vertical dorsal blades are held backward by elastic steel bands, and at the point where these are brought forward to be fastened they exert pressure on the cushion, that is, directly against the angles of the ribs, while the remaining blades exert no pressure at all on the body.

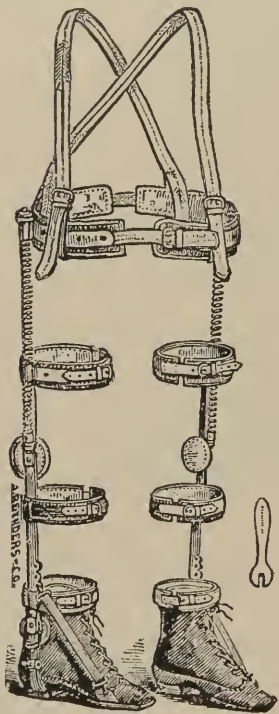


Fig. 24.—Doyle's Apparatus.

The toothed-wheel and toothed-bar are utilized in many orthopedic appliances for effecting reduction where we aim at considerable gradual extension by the apparatus. The toothed bar is also used with a surrounding metal spring, and this en-

Fig. 25.—Roberts' Elastic Extension Bar.

ables us to obtain fixation in a better position, and prevents return to a faulty one. This is exemplified in the Roeser-Baedenheuer club-foot shoe.

Formerly the screw mechanism played a great rôle in or-

thopedics, and this is not surprising, for, before the introduction of elastic traction, by means of the screw gradual and

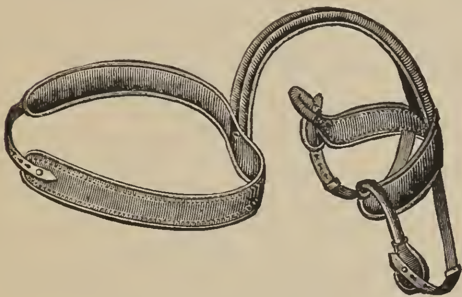


Fig. 26 a.—Nyrop's Spring Splint.

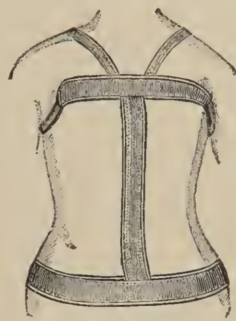


Fig. 26 b.—Beely's Corset.

great power could be obtained according to the desire of the surgeon.

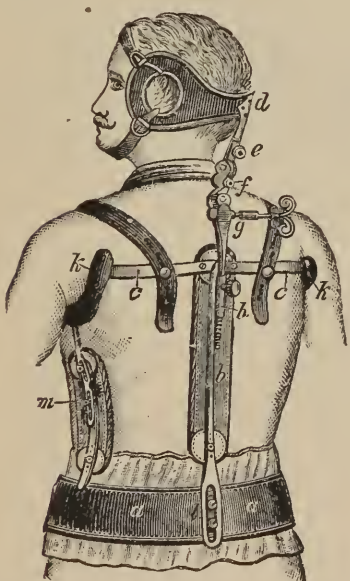


Fig. 27.—Reynder's Apparatus for Torticollis.

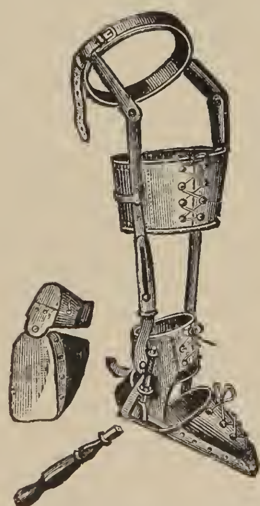


Fig. 28.—Kolbe's Club-foot Apparatus.

The most popular was the endless or Archimedes' screw, and this was utilized in many contrivances for contracture of the extremities.

While the simple endless screw is seen in many contracture appliances, such as the Ulrich and Mittler's hip-extension apparatus, the Langgaard knee-extension apparatus, the H. Bigg and the Goldschmidt's finger-extension apparatus, we also find the manifold endless screw utilized for the purpose of effecting reduction, as in club-foot appliances (Charrière, etc.), skoliosis contrivances (Langgaard, Eulenburg), torticollis apparatus (Fig. 27), Stillman's and H. Bigg's machines, for antero-posterior curvature of the spine, contrivances which naturally act the more effectively, the longer the lever arms which are adapted to them.

The screw mechanism is also utilized at the angle between two articulated splints, so that the distance between them can be lengthened at will by the screw. This is the case in Kolbe's elbow machine and in a number of club-foot appliances, etc.

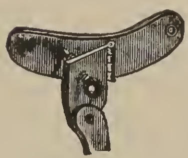


FIG. 29.—Screw in Bonnet's Apparatus.

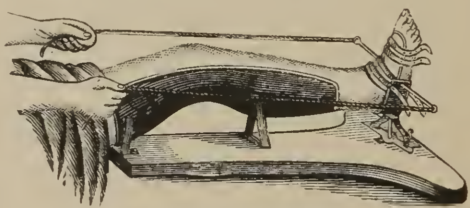


FIG. 30.—Bonnet's Machine for the Exercise of the Talo-tarsal Joint.

The *vis a pression*, which Guérin formerly used to a great extent, has to-day much less recognition. A simple screw passes through a stationary nut and presses on the movable arm of a lever, forcing down this end or preventing its elevation, so that excess of movement is impossible. This form of screw is seen in many club-foot apparatuses (Lutter's and Langenbeck's), the aim being to prevent the equinus position, and also in Bonnet's machine for the prevention of inward rotation (Fig. 29).

A further group of appliances are the self-movable machines, many of them ingenious and devised by Bonnet, by means of which the patient may himself exercise the functions of a joint by exerting passive motion, usually through a cord passing over a roller, on which the patient makes traction.

These machines allow of motion only in one level (the best known is Bonnet's appliance for knee-contracture), and in

order to apply passive motion to the foot, for instance, three machines are necessary and therefore apparatus of this nature

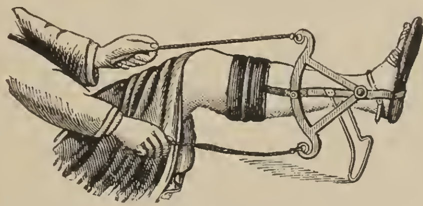


Fig. 31.—Apparatus for Movement of the Talo-crural Joint.

has yielded in general to movements applied through the hands.

In this place belong the appliances in which, by changing an elastic band from one to the other side, the movability of

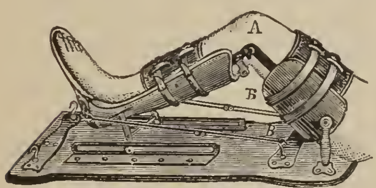


Fig. 32.—Changeable Elastic Traction for Correction of Knee Contractures. (Collin.)

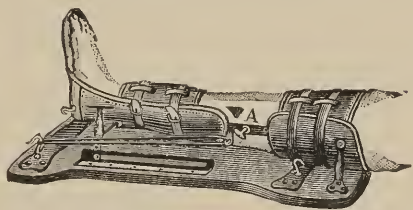


Fig. 33.—Changeable Elastic Traction for Correction of Knee Contractures. (Collin.)

a joint is increased (as in the Collin, and the Reibmayer contracture apparatuses).

SURGICAL ORTHOPEDIC OPERATIONS.

Surgical operations also play a most important rôle in orthopedics and in this respect has progress in modern times been most marked. The operations are: 1. Special manual, without injury to the skin, and, 2. Cutting procedures, and these may be either subcutaneous or percutaneous. It is evident why, at a time when, by any cutting method, there existed danger of abscess, suppuration, septicemia and pyemia, the subcutaneous method, owing to the slighter risk of wound complication, should have been preferred; to-day, however, owing to the aseptic methods of treating wounds, the open operations are growing more in favor. We need mention only the open myotomy of the sterno-cleido-mastoid, the Phelps operation for club-foot, etc.

We may further divide operations into those which are limited to the soft parts and into those which concern the bones; in both, however, it is essential that the after-treatment should be the correct one.

As regards the special manual operations without injury to the skin, they are intimately related to massage manipulations, extension by bandages, etc., of which we have already spoken.

When the insertion points of muscles become so approximated as to lead to deformity, the manual stretching of the muscles, with or without anesthesia, may be resorted to in order to overcome this deformity. Manual manipulations are oftener called for on account of inflammatory adhesions, etc., in or near a joint, and we will speak further of the method of *brisement forcé* under the subject of contractures; in general, the force used should not be too great lest rupture ensue.

If, by such methods, the malformation be corrected, then it becomes necessary to hold the part in good position by means of bandages, or else, through passive motion, to recover the normal movability and thereby to restore function to the limb.

In connection with the osseous system also, methods unassociated with injury to the skin are called for, and owing to the greater accuracy of the modern apparatus for osteoclasis, that is, the breaking of deformed bones by weight without the making of a wound, this method excels osteotomy. Usually osteoclasis is performed by lever action, either by the hand of the operator alone, or else with the assistance of special apparatus (osteoclasts), as a rule, under anesthesia. The hand is suitable especially in case of long, non-sclerosed bones. Many curvatures of the bones in infants, due to rachitis, provided sclerosis has not set in, may be bent straight with almost no force; the same holds true for badly united fractures before the callus has hardened. We work in these instances with both hands on each side of the eminence of the curvature, the thumbs being placed at the site of greatest curvature, and we may thus readily straighten the bone; we usually feel crepitus resulting from slight fracture, but this heals quickly under a fixation bandage. The English writers compare this fracture to the variety known as "green-stick."

Where rachitis with sclerosis has occurred, and this may

happen as early as two to four years, then the strongest man is not able to break the bone of a child, and here osteotomy finds its indication. In case of adults, only exceptionally is it possible to break a deformed bone manually (especially, for example, in case of badly united fractures of the fore-arm). Ordinarily, a large hollow bone may be broken by bending it over the knee or the edge of a table, etc., these points acting as resistances to the lever action, and when the bone is too short it may be lengthened by plastering on a splint.[46] Usually large arc-like curvatures, where sclerosis has not set in, yield best to such methods.

In the majority of instances in adults the requisite force must be obtained through special instruments, and here the chief difficulty is to obtain the fracture at the desired place. While, formerly, forcible extension by the Schneider-Mennel apparatus, etc., was the practice, to-day the ostecolasts are substituted, especially the improved ones of modern times.

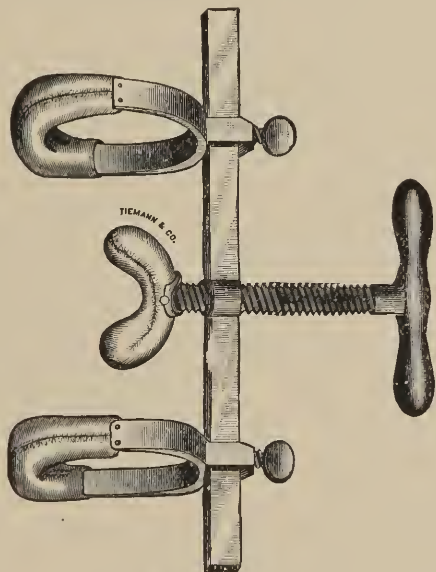


Fig. 34.—Rizzoli's Osteoclast.

With the majority of osteoclasts the portion to be operated upon rests on a hard surface, and at the site of greatest curvature force is exerted through a pad, etc., and thus the bone is fractured. The simplest instrument of this nature is that of Bosch,[47] which acts on the principle of the book-binder's press. Of the numerous osteoclasts (or dysmorphosteopalinclasts) those of Blasius, Oesterlen, V. v. Bruns, Taylor,[48]—we will only represent Rizzoli's (Fig. 34), which has been especially used for the fracture of rachitic curvatures, and which consists of two iron rings, the one applied above and the other below the site of greatest curvature; these rings hold the bone and are

connected by a bar through the middle of which works a screw. To the end of this screw is attached a plate, through which pressure is conducted at the eminence of the curvature which is covered by a pad. This pressure is increased till the bone is fractured. In order to measure the applied force a dynamometer may be attached to Rizzoli's osteoclast. The apparatus is a very simple one. The padded rings surround the bone; they are connected by the iron bar and fixed by screws; the large screw is worked down until the pad over the eminence of the curvature is thoroughly adapted, and then a

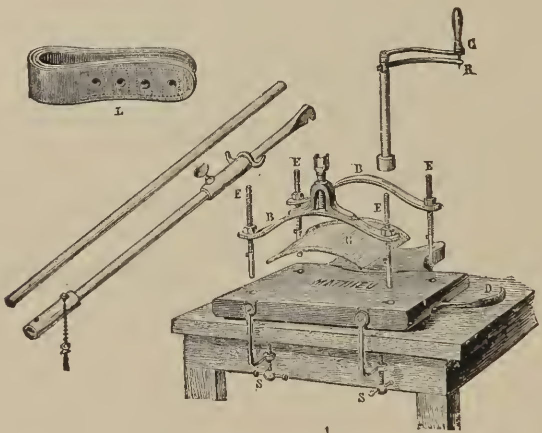


FIG. 35.—Robin's Osteoclast.

few quick turns of the screw will break the bone, often audibly. A fixation bandage or extension is applied.

The new apparatus of Robin and Collin has the advantage of breaking the bone at the exact spot desired; the fracture is usually transverse, and this apparatus is also suitable for breaking the bone quite near joints. These inventions have greatly stimulated resort to the osteoclast, especially in France.[49]

The Robin osteoclast consists of a strong wooden base which is screwed at *S* to a firm table. The wooden base is perforated for the insertion of iron bars *EE*, and these are fixed by the lever *D*. The arcs *BB* are movable on the bars *EE*, and these compress the plate *G*, by means of the screw-key *C*. The lever force is regulated by the spring *R*. The

force is applied to the periphery of the bone through the threefold leather girdle *L*.

The new Collin osteoclast, which was devised for the correction of genu valgum, consists of a firm base, to the centre of which is attached a strong quadrilateral iron plate which may oscillate forward and backward; through this plate works a compression screw, which is movable so as to be applied, where desired, on the bone. Of the two lever arms only one is movable, and when it is approximated to the other, the requisite force for fracture is exerted. (See Fig. 36.)

In many cases the very simple Volkmann apparatus, which consists of a ring and a long lever arm, may be used. The

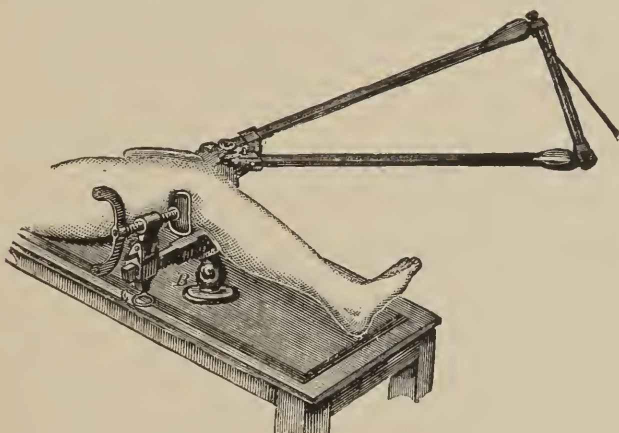


FIG. 36.—Collin's Osteoclast.

ring is pushed over the site where it is desired to cause fracture, and the requisite force is quickly applied through the lever.

According to Böckel,[50] of 120 patients with contracture of the extremities the above method succeeded in three-fourths of the cases, and for more than half the use of a simple apparatus sufficed. Thirty times osteoclasis was requisite, and with the exception of one case, it succeeded twenty-seven times in children ranging from eighteen months to eight years, and only failed three times.

Recent reports have strengthened the position acquired by osteoclasis and it is not surprising that statistical data should speak in favor of it over osteotomy. Pousson,[51] in ninety-eight

cases, has never seen much after-disturbances except in one case where there was a slight bruise.

In regard to the cutting methods, we must consider those involving the soft parts (skin, fascia, muscles, tendons), and those involving the bones (section of bones, removal of a portion).

The further subdivision is made into the so-called subcutaneous operations, which are performed through a small incised wound in the skin, and into the percutaneous operations, where the skin is severed in order to expose the part to be operated upon. While, in the days when man was powerless against wound complications the subcutaneous operations were naturally resorted to, since thus certain of the risks were avoided, in these days of antisepsis the percutaneous operations have had a wide prospect opened before them, since, by the free exposure of the parts, we may better recognize shortened tissue or the bands which prevent reduction of a deformity, and we may further the better separate them, and since we may, by Esmarch's bandage, avoid the hæmorrhage which would otherwise obscure the field of vision.

Of the operations on the soft parts, we must first consider those which consist in cutting the cicatrices which cause deformity. Where such cicatricial contraction exists we may reach our aim by simple incision of the bands, by transverse incision followed by vertical union, by flap operations, especially the Λ—, V—, and |—|-shaped incisions (Busch, Burns, etc.), by extirpation of the cicatricial tissue, and by transplantation of large flaps from the neighborhood.

The cutting of fascia and of aponeuroses is not frequently resorted to in orthopedics; usually this involves the palmar and plantar fascia, and the fascia lata in case of contractures, etc.

These operations may be also performed subcutaneously and percutaneously, and in regard to the palmar fascia we will speak later in connection with Dupuytren's palmar fascia contracture.

The cutting of single ligaments is also, in general, not often resorted to in orthopedics, although formerly the section of the external lateral ligament of the knee played a rôle in the treatment of genu valgum.

More frequently, it is a question of cutting different tissues,

as in Phelps' method of treating club-foot, where all the tissues which hinder redressement,—the skin, fascia, tendons, ligaments,—are cut, and the wound is then allowed to heal antiseptically.

In the orthopedic practice of earlier times, in particular, the cutting of muscles and of tendons for the correction of deformities played a very important rôle, and tenotomy is of far greater value than myotomy, and should be selected instead, seeing that the necessary wound is a slighter one, its cross-section a smaller one, and, owing to the speedier union, the subcutaneous operation will to-day, in the majority of cases, be given the preference. Especially is this the case for those tendons, such as the tendo Achillis and the tendon of the sterno-cleido-mastoid, which are not surrounded by any special sheath and therefore where the risk of permanent non-union need scarcely be taken into account.

The section of muscles and of tendons was even resorted to in the middle ages for the correction of deformities, but suppuration, etc., frequently resulted and this nullified the result. Tulpius, Solingen, Roonhuysen performed tenotomy; Lorenz, on the advice of Thilenius, in 1782, for the first time cut the tendo Achillis for the relief of club-foot, and Sartorius and others imitated him. In 1822, Dupuytren and others tenotomized for caput obstipum. Tenotomy, however, first gained acceptance as a valuable operation after L. Stromeyer (1831 to 1833) had learned how to avoid its risks, and we may, with justice, say that orthopedic practice was thus revolutionized as much as was ophthalmology by the discovery of the ophthalmoscope (Bauer). The enthusiasm which this operation evoked was all the greater, seeing that, in comparison with the great results it yielded, it could be termed a minor operation. Dieffenbach, especially, cultivated the method in his large practice, so that in his work on the section of tendons and of muscles, which appeared in 1841, he could report 120 cases of torticollis and 350 of club-foot where he had tenotomized, and in one year he performed no less than 250 operations of this nature.

As in the case of many new methods, tenotomy was resorted to far too frequently, and we may rightly speak of "excess in tenotomy" when we read of cases where twenty and more tendons were divided in a single individual. In a

large proportion of instances which were formerly tenotomized, we may to-day attain our aim through the use of orthopedic contrivances (elastic traction, etc.); there still, however, remain a large percentage of orthopedic affections (especially contractures of the foot, torticollis, etc.) where a tenotomy will considerably shorten the time requisite for treatment, and for this reason it should be resorted to. In any event section of a tendon will only be of utility when the necessary after-treatment is instituted, and herein there was formerly, and there is to-day, much still to be desired.

Union after tenotomy consists in the following steps: The small space between the severed tendon generally fills up with a little blood, the coagulum becomes organized; the paratendinous tissue is involved in the plastic infiltration, and since the original plastic material spreads into the connective tissue, the ends of the tendon become united by connective tissue fibres which possess all the characteristics of tense connective tissue. Paget,[52] Lebert, Ammon, Brodhurst, have carefully studied the steps of this process.

In regard to the technique of subcutaneous tenotomy, we need small, curved or straight, pointed or rounded, convex or concave knives, the so-called tenotomes, which should only make a short cut in the transverse diameter of the tendon. The pointed tenotomes, of which the slightly sickle-shaped tenotome of Dieffenbach may be taken as the type, have the advantage that no other instrument is required for the operation, and further, in that careful use does not carry with it the risk of unnecessary wounding of the tissues.

The blunt, rounded tenotomes possess various shapes. In their use the tissues are incised at the desired spot by a small bistouri; the tenotome is inserted into this incision and the tendon is cut. Two instruments, therefore, are requisite for this small operation, and this is always a disadvantage.

The little instrument of V. v. Bruns combines the advantage of both, in that the point is cutting and is curved forward to such a degree that, after, by a quick stroke, the tissues have been cut, the tenotome may readily be pushed down to the tendon and then the tenotomy may be performed without risk of injuring the neighboring parts.

Owing to the short time requisite for the performance of this operation anesthesia is not absolutely essential; still, many

authorities recommend it, seeing that the movements of the patient may interfere with the operation. With good assistants, however, especially in children, the limb may usually be held so that there is no indication for anesthesia on this score.

It is always essential that the patient should occupy a position in which the part to be operated upon may be steadied to the best advantage, and that the limb be so held that the shortened tendon may spring well forward. Tenotomy is then performed, as a rule, at the spot where there is least danger of injury to the neighboring parts and where the tendon has the least transverse diameter.

The incision on the border of the affected tendon should, as far as possible, be made in the direction of the fibres of the tendon; it should be small (to avoid entrance of air), and should

FIG. 37.—Tenotomes. *a*, Guérin's Lancet-shaped Knife and Blunt-pointed Tenotome; *b*, Stromeyer's Tenotome.

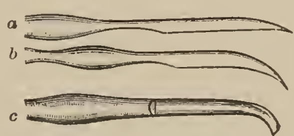


FIG. 38.—Tenotomes. *a*, Straight-cutting Tenotome; *b*, Dieffenbach's Tenotome; *c*, v. Bruns' Tenotome.

further be made on that side which is the most convenient for the operator in the use of his instruments.

The position of the tenotome during tenotomy is somewhat like that of a knife while peeling fruit; the tendon is rather held against the tenotome; the motion of the instrument should be rocking not sawing. The tenotomy may be performed either from within outward or from without inward.

In case of tenotomy from within outward the left hand of the operator, or of an assistant, holds the affected limb so that the tendon which is to be cut springs sharply forward; the operator, holding the tenotome in his right hand, inserts it into the small incision near the border of the tendon, carries the instrument flat under the tendon nearly to the skin on the opposite side, turns the instrument to an angle of 90°, so that the cutting surface lies against the tendon and this is severed by a number of slight tractions, while the thumb of the operating hand controls the action of the instrument.

When the tendon has been severed, and this is generally evidenced by an audible crackling, the tenotome is again turned on the flat and pulled out through the same incision, the wound being at once compressed by the finger and then dressed antiseptically.

In case of tenotomy from without inward, the limb is held so that the tendon is not put on the stretch, and the tenotome (blunt like Guérin's or Bruns') is inserted flat through the wound above the tendon, between it and the skin, until it has passed the tendon; the tendon is then made tense, the operator then presses the back of the knife outward, the tendon is cut through in part by the tension, and an audible crackling, with an immediate yielding, tells us that this has happened; the extension is relaxed, the little knife is turned and slowly drawn out of the wound horizontally; a compressive antiseptic bandage is at once applied.

It is important that the operator, or his assistant, should at once relax the tension of the tendon as soon as it has been cut, and that immediately on the withdrawal of the tenotome from the wound, the blood should be pressed out of it and an antiseptic dressing applied.

The correction of position should, as a rule, not be resorted to immediately after the tenotomy; it is preferable to wait until the trifling wound has healed, usually about three days at the earliest; the correction, further, should not be sudden but gradual.

The complications following tenotomy may be stated as the following:

1. Profuse hæmorrhage from wounding of a large vessel, which calls for a compressing bandage, rarely for the ligature.

2. More frequently it happens that, owing to movement on the part of the patient, the wound in the tissues is greater than is essential, or that the tissues on the opposite side are pierced. Such occurrences are of no importance if the after-treatment be in accordance with antiseptic principles.

3. Incomplete section of the tendon may lead to difficulties, seeing that the operator must forcibly rupture the remaining fibres, or else insert the tenotome again in order to completely sever the tendon.

Suppuration after tenotomy is to-day a rare occurrence; it may happen, however, in uncleanly children, and then care

must be taken to secure free drainage, lest gangrene, etc., of the tendon ensue.

Myotomy is less frequently indicated than tenotomy. At times free section through a large wound may be advisable, since we can thus better loosen cicatricial bands, etc. A large incision is especially indicated in Phelp's operation, or in the percutaneous section of the sterno-cleido-mastoid, in order to avoid, with greater certainty, injury to vessels and the resulting sequelæ. The modern operations on the osseous system mark still greater progress in orthopedics than the introduction of tenotomy. Such are the operations of osteotomy, osteoectomy, resection, arthrodesis, etc., and they have been made possible by the modern methods of treating wounds antiseptically. These operations constitute a most valuable advance in surgery and are applicable generally whenever osteoklasis and other mild procedures cannot promise sufficient result or are out of the question, or where treatment by apparatus, owing to cost and length of requisite time, cannot from the circumstances of the patient be instituted.

Although section of bone was performed in remote times (Avicenna) and lapsed into forgetfulness, and although in the pre-antiseptic era it was again practiced as subcutaneous osteotomy by A. Mayer and Langenbeck, yet severe after-disturbances, death from pyemia, etc., not infrequently occurred, and only on the advent of the antiseptic era did these operations on the bones become established, and they are, to-day, frequently practiced to circumvent deformity, to overcome anchylosis, old dislocations, and badly united fractures.

In regard to the instruments which are requisite for these operations, in addition to the ordinary scalpels, etc., bone knives or resection knives (Langenbeck, Billroth, Nélaton, Bruns, etc.), and rasps must be mentioned. To-day the chisel plays a great rôle in these operations (Billroth, Volkmann). The carpenter's chisel, which is sharpened on one side (Fig. 39, *b*) and answers for the removal of pieces of bone, is not only used but also the sculptor's chisel (sharpened on both sides, Fig. 39, *a*), which has the form of a slender wedge. The latter is resorted to for simple perforation of bone. The chisel must be constructed of well-tempered steel; it must be sharp and in various sizes. The handle should end in a metal knob or else be of hard wood so that it will present a broad, firm surface

for the hammer to act upon. The hammer may be constructed either of lead or else of hard wood (*lignum sanctum*, etc.).

Before the general introduction of the chisel operations, the saw, in particular the panel saw (Langenbeck, Adams), was widely used, and the latter, in particular, is for many instances a very useful instrument, since it is only dented at the upper end, and the soft parts, hence, may be the better protected. This form of saw is especially useful when it is a question of cutting through a superficial, readily accessible bone, or when the bone is sclerotic, or when only the cortex of the bone is firm. In the cutting of large bone surfaces, as in the

Fig. 39.—Chisels.

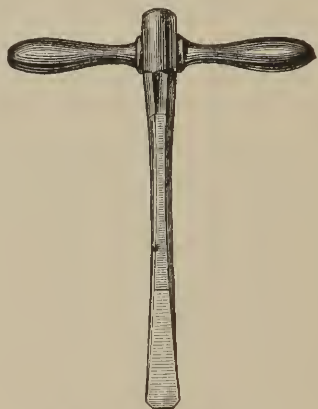


Fig. 40.—Billroth's Osteotome.

ordinary orthopedic resection, the saw is preferable, since it yields smoother sections, and then the resection saws of Szymanowski, Bruns, Farabœuf, Mathieu, and others, are valuable, especially those with large arcs; for many purposes the rotatory saws (Charrière's) and Ollier's "scie à volant" with elastic transmission are valuable.

The use of the chain saw is generally to be discountenanced, owing to the difficulty of obtaining proper antisepsis.

The bone perforator is used less for the purpose which its name implies than for the introduction of a ligature, and the instruments of Collin, Langenbeck, and others may be resorted to; the ordinary gimlet will usually answer. The bone scissors are rarely called for in orthopedics, and are only useful for the severing of thin bones with small narrow canals, or flat

bones, or fragile readily depressed bones (as in the tubular bones of children with thin cortical layer); the bone forceps, on the other hand, is frequently required for the purpose of leveling a surface, or, of removing sharp projecting portions of bone. Liston, Luer, and others have devised bone forceps.

Osteotomy, that is to say, the section of a bone without the removal of bone substance, may be performed in a variety of ways: as a simple linear osteotomy (generally transverse section), as more or less oblique or as bow-like osteotomy.

While formerly osteotomy was performed through as small a wound in the tissues as possible—the so-called subcutaneous linear osteotomy—in order to avoid the danger from entrance of air, since the introduction of antiseptics less weight is laid on the wound in the tissues, and under these circumstances the bone is freely exposed. Under careful antisepsis osteotomy is a safe and certain operation.

To cite a few examples: R. Volkmann,[53] in fifty-seven osteotomies, observed neither suppuration nor fever; in only one case was subsequent amputation called for, all the others yielding good results; in forty-two osteotomies Hofmokl reports thirty-one instances of healing *per primam*, suppuration in ten cases, one death; in 361 osteotomies Margary had three deaths (only one of which could be laid to the operation), and MacEwen,[54] in 835 osteotomies (557 of which number were performed on the legs) had no death. These good results, however, should not lead to excessive performance of the operation, for Owen says, "I have seen pyemia and death follow the operation when performed by a careful surgeon with all Listerian precautions, etc.;" where osteoklasis will lead to the same result it is to be preferred, since Pousson, for example, in 276 osteotomies noted severe disturbances ninety-five times (four times hæmorrhage, fifty-four times suppuration, etc.), and in only fifty-eight did union by first intention occur.

In the performance of osteotomy, formerly, the bone was bored through with the perforator a number of times, or after a single perforation the bone was sawed until it was possible to break it; to-day the chisel is the chief instrument used in the majority of cases (MacEwen's osteotome) and in order to note its progress in the depths of the wound the instrument is graduated (Reeves).

In the choice of site for the performance of osteotomy we

must take into consideration the necessity of not injuring the neighboring parts; as a rule, a vertical incision is made down to the bone; when necessary, muscles are cut through lengthwise, and tendons, etc., are pushed aside. After the chisel has been applied where desired it is driven by blows from the hammer, either the right hand of the operator holding the latter, or else, where great care is requisite, an assistant using the hammer and the operator guiding the chisel with both hands.

A simple "linear osteotomy" is performed as follows:

The patient is deeply anesthetised; as a rule Esmarch's bandage is applied;[55] the limb is shaved, washed with soap and disinfected according to antiseptic requirements, and is laid on a sand-bag or cushion covered with rubber-sheeting. A short vertical incision down to the bone is made at a point where the bone is as superficial as possible and where the vessels and nerves will be injured the least. A chisel of the breadth of the wound is inserted along the knife, so that when the latter is removed the former will rest transversely on the bone. By a number of sharp blows with the hammer the chisel is driven in until the bone has been nearly severed and the remaining cortical layer can be readily broken. The wound is again washed out antiseptically, is brought together by sutures and bandaged, and the limb is then placed in a retention bandage or splint, and slung up for awhile, a procedure which is of special utility in children, since the dressing is thus less likely to be soiled. If fever or other disturbance do not call for a change of dressing, it may remain in place for one to two weeks, and the retention bandage is to be worn until thorough consolidation has taken place. Ordinarily an apparatus must be worn for a number of months or even for a year.

A special variety of osteotomy is the semicircular (Meyer, Rosmanit, and others), where the bone is cut through in a semicircular line, eversion of the edges being thus prevented. Greater contact of the surfaces and better adaptability are obtained by this method. Under this heading belongs the trochlea-shaped osteotomy which Defontaine[56] has recently performed in case of anchylosis of the elbow.

We must further mention vertical osteotomy. This procedure was devised by Ollier[57] for the correction of rachitic curvatures and at the same time to lengthen the shortened

bones through longitudinal extension applied to the cut surfaces. This procedure calls for great permanent extension in order to overcome the resistance of the muscles, and it may also require tenotomy. Ollier has thus secured an increase in length of from .7 of an inch to 1 inch and a fraction.

In case of very considerable, and in particular right-angled curvatures, where shortening is lacking or even increase in length is present, the wedge-shaped osteotomy (*osteotomia cuneiformis*) is to be preferred. A wedge of bone is removed from the convexity of the curvature and the cortex of the bone is broken toward the concavity. In general, this wedge-shaped excision is performed in order to obtain good position in case of angular anchylosis. A wedge of bone is removed sufficient in size and in form to allow of restitution of the bone to a good position. The apex of the wedge lies in the bone, that is to say, the latter is not entirely cut through. The posterior wall is fractured with due regard to the safety of the neighboring parts.

The limb, rendered bloodless, is firmly held, and a sharp carpenter's chisel is placed obliquely on it. With a few blows of the hammer the chisel is driven in to the requisite distance, injury to the periosteum being avoided as much as possible; the opposite side of the wedge is similarly cut, and, after the remaining bridge of bone has been broken, the bone surfaces are adapted the one to the other, the wound is sutured, dressed antiseptically, and the bone is held in position by a suitable retention apparatus.

In certain instances, where, for instance, the bone is very compact, as in the knee, the saw may be substituted for the chisel, even though resort to it requires greater exposure of the bone; in this case the periosteum must first be loosened and pushed out of the way.

Rarely is it requisite after the wedge-shaped excision to bring the bone surfaces together by suture or by nails.

A number of new orthopedic operations, allied to osteotomy, have been devised, chiefly by Ollier,[58] with the aim, in the young, of checking or of entirely preventing local growth of a bone, and exceptionally of increasing this growth. These operations are, in particular, indicated where the growth of two connected bones is unequal, especially in a longitudinal direction, as, for example, in the bones of the fore-arm, thus

leading to deformity. Where the object is purely to check growth, simple chondrectomy may be resorted to. In case of beginning deformity (as in genu valgum, etc.) a simple incision may be made into the epiphysis; often, however, this will not suffice, although the attempt risks nothing (Ollier.)

Where the aim is to stop growth, particularly in older children, chondrectomy is indicated. This operation consists in removing a portion of the epiphysis, occasionally its entire thickness. For example, where the radius from one or another cause is shortened and where the growth of the ulna may lead to hideous deformity (subluxation of the hand), here only resection of the epiphysis can permanently check the deformity.

As yet we have had too little experience with these operations, which are based on theoretical views in regard to the growth and the regeneration of bone; the same remark holds true of the proposals to artificially cause increase in the growth of bone by scarification of the periosteum, by the insertion of irritants (such as the driving of a nail) in the neighborhood of the epiphysis. Ollier, for example, was able to increases the length of the tibia by about half an inch through repeated cauterization of the diaphysis, or through subperiosteal laceration.

The resection of a portion of bone, or of a portion from two bones in contact, is often resorted to since the advent of the antiseptic method of wound treatment. The so-called resection *en bloc* (Gurdon Buck) is utilized in case of bony anchylosis of joints (anchylosis of the knee at a sharp angle), either for the purpose of obtaining a movable joint (as at the elbow, the shoulder, the jaw) or else only in order to obtain better position from the stand-point of function.

Further still, resection of a joint is undertaken in order to obtain better function in irreducible or in old dislocations, and also in instances of congenital joint deformity.

In case of curvatures, resection of the joint is also resorted to, as for example, in case of aggravated pes equinus, and we must also refer here to the procedure, frequently performed to-day, of removal of wedges of bone from the foot in instances of club-foot.

Less frequently is resection from the diaphysis indicated, as, for example, in badly united fractures where union has occurred at an angle, in pseudarthrosis, etc. Güterbock [59] has

excised a piece from a large radius, in order to correct angular ulnar-ward bending of the fore-arm.

Resection, performed for orthopedic purposes, often differs somewhat from the ordinary operation. Instead of the usual longitudinal incision, flaps are often raised in order to secure good exposure of the bone. Only sufficient bone is in general removed as will suffice to obtain correct position, etc.

In case of resection *en bloc* we must carefully estimate the size of the wedge which it is necessary to remove, and, where, in addition to flexion, there exists a lateral deviation of the bone, the section, if removed, must be higher on the one side than on the other.

Usually, the requisite size of the wedge may be estimated by the eye; sometimes it is necessary to make a plaster model of the limb, and with this to experimentally secure a wedge of the necessary size.

We must refer, under this heading, to the many methods, recommended in particular by Albert, of operating on the joints, such as removal of the excess of bone from some part of the joint surface, whereby an entirely useless limb has its function restored, partially at least, or whereby firm supports may be attached to such a limb. (See, in this connection, the subject of paralytic deformities.)

Plastic operations may also be resorted to for orthopedic purposes. Nussbaum, Ollier, and others, have been successful with bone transplantation in case of pseudarthroses, etc.; and Albert has undertaken a plastic method in case of a congenital defect in order to afford good support to the affected limb. In a female child, nine months old, with congenital defect of the tibia, he opened the knee-joint and implanted the fibula between the two condyles. The child convalesced without fever, and bony union was obtained with the limb at but a slight angle.

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CHAPTER II.

RACHITIS.

THE most frequent cause of deformity, in particular of the lower extremities, is rachitis. Under this term we understand a constitutional disease, a special anomaly in nutrition, which is due to an excessive increase in, together with a deficient calcification of the elements from which bone is formed. This disease is most prone to occur in childhood. The synonyms for rachitis are: German: Englische Krankheit, Zwiewuchs; French: rachitisme; Italian: rachitismo.

This disease is found the world over,[1] especially in cold and moist climates (Holland, England), and it affects, in particular, the poorer classes who live amid bad hygienic surroundings, their houses being dark and ill-ventilated, their nourishment insufficient and of poor quality. Rachitis, indeed, constitutes a very high percentage of the diseases which affect dispensary patients. Owen places this percentage as high as 30 per cent.

It is questionable if heredity plays a rôle in the establishment of rachitis. Many authorities claim that it is an hereditary form of syphilis,[2] but this view is not tenable for the majority of cases.

In general, bad hygienic surroundings, exclusive nourishment on bread, pap, and poor milk, insufficiency of light and of air, these factors are very influential in the etiology of rachitis. The disease is only exceptionally met with in infants reared at the breast, and more frequently in those which are bottle fed.

Baginsky and Roliff have been able to produce rachitis, experimentally, by removing the lime salts from the nourishment; others by the administration of lactic acid. Heiss, however, has not been able to confirm the latter statement.

Rachitis may begin even in intra-uterine life; Chance, in-

deed, claims that in all cases such is the origin. The most frequent form of the disease is infantile rachitis, which appears during the first two years of infancy, that is to say, during the period of dentition (from the fourth to the thirtieth month). While, further, rachitis often enough develops in childhood, it is an infrequent affection in adults and in old age. The disease generally appears extensively throughout the body, rarely being purely localized.

After vague general symptoms, such as fever, diarrhœa, disturbances of digestion, tendency to catarrhal affections, profuse perspirations, the nutrition of the body diminishes and the alterations in the bones appear. These alterations affect very differently the various bones, and they are the chief cause of curvatures, the abnormlly softened bones yielding to the traction of the muscles.

In nearly 1,000 cases Treeves found almost constantly swelling of the lower end of the radius and of the ulna; in 250 cases the clavicle was bent, in 115 the humerus, in 210 the spinal column was affected, usually in the form of skoliosis. Most frequently the changes were noticed in the lower extremities; in 300 cases the femur was bent to a greater or less degree; in 415 genu valgum, or bow-legs, were present; in 394 the joints were enlarged; in 294 genu valgum predominated. Chance, also, found that thickening of the lower end of the radius was a constant phenomenon. In 600 cases he determined thickening of the malleoli 300 times, bow-legs 368 times, genu valgum 396 times, curvature of the femur 142 times.

The changes in the skull are of general interest. The most essential consist in an enlargement of the occiput out of proportion to the face. Shaw states this relation to be 7:1 instead of 6:1. The parietal protuberances project markedly, the fontanelles remain open. Elsässer first called attention to the craniotabes (the thinning out of the bones of the posterior portion of the skull). This thinning results from pressure on the bones when the child is recumbent, and it may lead to severe disturbances, such as spasm of the glottis.

In the thorax the changes first appear as a swelling at the point of junction of the ribs and the cartilages, forming the so-called rachitic rosary. Gradually the ribs yield to the inspiratory traction, and the lateral walls of the thorax, where the ribs have the least resisting power, sink in, the sternum

projects like the prow of a vessel and presents the appearance of a hen's breast (*pectus carinatus*). This is a frequent rachitic deformity, and a further etiological cause is the pressure of the arms against the sides.

In the spinal column, in addition to the softening of the bones and the swelling of the cartilages, the weakening of the muscles is effective in leading to deformity. Owing to the lack of power in the muscles the spinal column bends and, in course of time, permanent deformity ensues, usually a skoliosis or lateral curvature.

Under the influence of the rachitic softening of the bones the pelvis undergoes the characteristic changes leading to the flat, the elliptical, the kidney-shaped, etc., pelvis. The changes here are met with in varying degree and extent.

The changes in the extremities are of chief interest to us. At the outset, the thickening and broadening of the epiphyses are characteristic. These alterations lead to the joints appearing as if double, whence the expressions double-jointed, *Zwiewuchs*, etc.

In addition to the deformity resulting from enlargement of the epiphyseal cartilages, a similar effect may follow on unequal extension of this process, and when we add to this unequal traction of the muscles the highest grade of deformity may ensue. According as to whether the child walks or not, the deformity varies in characteristics. Usually, we find an increase in the normal curvature of the limbs, that is to say, in curvature outward. In aggravated instances an angle is formed, especially in the lower third of the lower extremities, and the deformity may extend to such a degree that the feet are crossed.

Curvatures with the convexity inward (Figs. 41 and 42) are less frequently met with, and in these instances, unequal pressure on the knees in creeping probably plays a rôle. The most complicated curvatures may result from repeated partial, or total fractures, and these are indeed frequently symptomatic of rachitis.

The rachitic changes of the upper extremities are of less importance. The most characteristic is the projection of the lower epiphysis of the radius (Fig. 42). The curvatures of the humerus, usually with the convexity inward, form a zigzag line with the fore-arm, where the convexity is outward. Ra-

chitic changes in the clavicle are often found. The rachitic flat foot is a characteristic affection.

The pathological findings consist in an increase of osteoid matter, with diminished and unequal calcification. The epiphyses of the hollow bones are thickened, the periosteum and medullary substance are hyperæmic; on section the epiphyseal line is irregular; here and there in the bones are zones of thickening; the medullary spaces spread irregularly into the thickened sections; the periosteum may be readily detached and is very succulent.

These stages of rarefication and of effusion may be differ-

FIG. 41.—Rachitic Curvature of the Lower Limbs.

FIG. 42.—Rachitic Genu Valgum in a Four-year-old Child

entiated from the stages of beginning deformity, of consolidation and of eburnation.

The epi- and diaphyseal thickenings disappear only slowly, and not infrequently they are permanent. In case the rachitis is cured there results a rachitic sclerosis, that is to say, an increase of the bone, as calcification and ossification of the osteoid layers, whereby the bones increase greatly in weight, and they become so hard and so compact that it is often very difficult to crush them.

Usually a greater or less disturbance in the growth of the body follows on rachitis. According to v. Rittershain, for

example, the mean height of the body, at a given age, is never attained. Not uncommonly rachitis results in the individual being dwarfed.

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CHAPTER III.

TORTICOLLIS.

UNDER the term torticollis or wry-neck is understood that pathological position of the head when it is bent toward the shoulder, and the chin is directed toward the opposite side. The condition may occur before birth, during delivery, or it may be acquired later in life. The acquired form is divided into the myogenous, the arthrogenous and the cicatricial, and in addition there is a variety called the compensatory which is seen as an accompaniment of aggravated skoliosis.

In regard to congenital wry-neck heredity possibly plays a rôle; at least Petersen reports an instance where a number of children in the same family were thus affected. In the majority of congenital instances, however, the wry-neck depends on a congenital deformity of the vertebræ of the neck, or else on lack of space for the fœtus during intra-uterine life (the result, for instance, of deficiency in the amount of liquor amnii). That contracted space or abnormal position in the uterus is a factor is rendered probable by the frequency of other deformities as accompaniments of wry-neck.

According to Stromeyer, in a large proportion of cases torticollis is due to rupture of muscular fibres intra-partum, and the subsequent cicatricial contraction. This view is shared by Fischer, Busch and others. Volkmann does not entirely reject it. Petersen,[1] however, was not able to determine a direct connection between the subcutaneous ruptures, the hematomata of the muscles, and wry-neck; neither did the experiments of Fabry and Witzel prove such a relation. According to Petersen hematoma is rather found in an already existing torticollis, and Fasbender has seen the hematoma on the side opposed to the wry-neck.

A variety of etiological factors must be taken into account. We must grant that in certain of the cases traumatism during

delivery[2] (breech presentations, the application of forceps) was the causal factor. For instance, Fabry,[3] in fourteen cases, found that in eight the presentation was of the breech and in four that the forceps was applied. A larger proportion of cases are myogenous in nature, being dependent on rheumatic and other influences which lead to a shortening of the sterno-cleido-mastoid. The posterior muscles of the neck may likewise become shortened on one side, and Délore calls this condition torticollis posterior. In rarer instances shortening of the platysma myoides may result in wry-neck.

Paralytic torticollis may be met with, seeing that paralysis of one sterno-cleido-mastoid may be accompanied by shortening of the other. Disturbances of the nerves, such as paralysis of an accessory nerve, may lead to torticollis. We are particularly likely to meet with torticollis as an accompaniment of hysteria, and it has been observed in the course of this affection as a clonic spasm of the muscles of the neck.

Torticollis of an arthrogenous nature is dependent on diseases of the cervical vertebræ and of their ligaments. It usually follows on unilateral cicatricial contraction. The fungous and tubercular diseases in this locality may be cured with angular anchylosis, and we will refer to this under the subject of kyphosis.

Cicatricial torticollis results from burns, abscesses, lupus of the soft parts of the neck. The cicatrices following on degeneration of the glands of the neck are also causal factors. Torticollis has also been noted as an accompaniment of tumors of the sterno-cleido-mastoid. Graser has lately reported a striking example.

Since the time of Tulpius, Robert, Bouvier, and others, anatomical descriptions of torticollis have been rare. The conditions observed on operative interference have been, on the other hand, frequently described and are important. In certain severe cases nothing abnormal has been found either in the muscle or its surroundings which would point to an antecedent trauma. In many cases, however, there have existed cicatrices in the muscle, and occasionally very marked changes which could only be due to a severe and extensive inflammatory process (Volkmann).

Hensinger,[4] for example, found the sterno-cleido-mastoid of one side one-half an inch shorter than that of the other. The

shortened muscle, however, was increased in breadth, and at the broadened and thickened portion there remained no muscular substance but there existed a soft, sinewy cicatrix.

Witzel,[5] at the autopsy on a woman of forty-four, affected with wry-neck of the myogenous variety, found the cervical vertebræ curved with convexity forward; the left sterno-cleido-mastoid was altered into a round, sinewy band, its border being only four inches long and .39 of an inch wide, while the right sterno-cleido-mastoid was seven inches long, and .56 of an inch wide. There existed asymmetry of the face and head

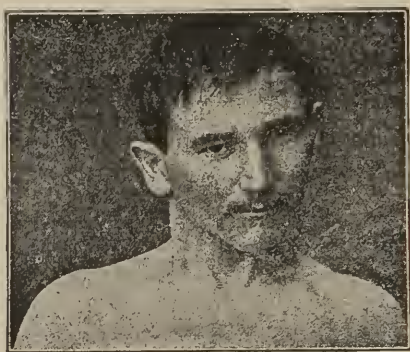

Fig. 43.—Congenital Torticollis. (Asymmetry of the Face.)

and a compensatory curvature of the lower spinal column (convex to the left).

Whether the cause of the wry-neck be congenital or not, there is rarely lacking a certain asymmetry of the face.

Nélaton, Eulenberg, and others, claim that this asymmetry is dependent on a lesser development of the vessels and the nerves on the side of the concavity; Dieffenbach considers it due to traction of the shortened muscles; Witzel believes that it results from stretching of the soft parts, in particular of the muscles of the healthy side of the face, whence the shape is imparted to the growing skull.

In Fig. 43, a man of twenty-four is represented with congenital right-sided torticollis and quite marked asymmetry of the face.

The symptoms of torticollis consist in the abduction of the head toward the affected side, associated with a traction (rotation) toward the healthy side. There exists an abnormal

position of the head and neck which results from the approximation of the insertion points of the affected sterno-cleido-mastoid. The chin is drawn upward, the head pulled somewhat backward. The ear is nearer the shoulder of the affected side; the projection of the muscle is very striking, and the insertion points of the sterno-cleido-mastoid are usually very well marked (Fig. 41). The neck appears not to exist on the affected side; the entire half of the face on the same side is shorter and thence the appearance of asymmetry.

We may readily detect limitation of the active and passive movements.

It is not sufficient for diagnostic purposes to establish the

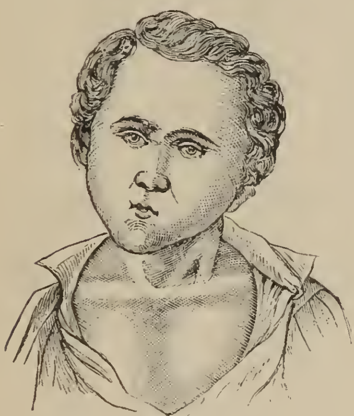

Fig. 44.—Torticollis, Lat. Sin.

Fig. 45.—The Same, after Tenotomy.

mere fact of the existence of wry-neck. The cause of the deformity must be sought for. The rational history must be carefully weighed; the cervical vertebræ must be examined to see if pain can be evoked on pressure or if there exists any swelling. Diseases of the vertebræ (in which event pain, fever, etc., are present) and dislocation of a vertebra must be differentiated.

In case of myogenous wry-neck the contracted muscle may be felt on the side of the concavity, while in dislocation of a vertebra such is not the case.

Boyer's statement that in paralytic wry-neck the abnormal position may be readily overcome is not an absolute one.

The prognosis of wry-neck, particularly the common myo-

genous form, is in the large proportion of cases good. By means of suitable apparatus, and in aggravated cases by means of tenotomy and the proper after-treatment, the deformity may be overcome, and even the great asymmetry of the face will then disappear after a few months.

In congenital wry-neck, the result of muscular rupture, if it be seen before cicatricial contraction of the sterno-cleido-mastoid has become established, the wearing of a suitable neck-bandage for a few months will prevent permanent contracture. Usually, however, the affection in an early stage is

Fig. 46.—Sayre's Wry-neck Apparatus.

Fig. 47.—Bruns's Wry-neck Apparatus.

overlooked, and is only determined after it has reached a considerable grade.

While, then, in infants, daily repeated rotation, manipulation with subsequent fixation, and in older cases, daily extension by means of Glisson's swings (Berend, Petersen) will suffice to effect cure, in adults, as a rule, special apparatus or tenotomy is requisite.

The simplest apparatus consists in the use of elastic traction. Sayre, for example, draws the head to the side opposed to the deformity by means of a rubber band which is attached to a strip of plaster around the forehead and to an axilla strap around the shoulder opposed to the deformed side. By varying the tension of the rubber band the head may be maintained in good position (Fig. 46).

For the rectification of wry-neck a number of appliances have been devised, such as those of Delacroix, Bonnet, Bouvier,[6] Mathieu, Collin, Bigg, and others. These take their point of resistance on the trunk and by means of screws and joints the faulty position is rectified. A number of these appliances are attached only to the upper part of the trunk; the majority, however, are provided with pelvic bands, dorsal splints, etc.

Bruns's apparatus consists of four padded sheet-iron splints, which may be curved to correspond to the shape of the parts to which they are to be adapted. These splints are united into a quadrilateral frame which may be slipped over the head. Union of the splints is effected so that the shoulder parts are movable. At the centre of the convexity of the shoulder and thoracic portion there is a screw-joint by which the component portions of each splint may be approximated, and into which the steel tubular rods, which are attached to the head, are inserted. These rods may be screwed up or down to suit the individual case, and their extremities are cushioned. The apparatus is attached to the body by straps which fit on to hooks in the splints. (See Fig. 47.)

Weinberg[7] has devised a combination of a chin-plate with shoulder straps, united together by springs and screws, the action of which is to approximate both portions of the apparatus. Lücke[8] has devised a similar apparatus for lifting the head in case of contraction of the sterno-cleido-mastoid as well as for use in case of caries of the cervical vertebræ.

Richard's apparatus (Mathieu) consists of a leather pelvic girdle, into the back of which is adapted an iron splint which extends vertically upward. At the upper third of this splint there is a longitudinal bar to which axilla straps are adapted. These straps pass under the axillæ, over the shoulders, and are attached posteriorly to the leather waist band. The upper extremity of the vertical bar is connected by means of a movable ball and socket-joint with a leather cap which fits the head. By means of this apparatus the head may be fixed in any desired position. (See Fig. 48.)

In Langgaard's[9] apparatus the head, which is drawn down toward the shoulder, may be lifted up and the pathological twisting may at the same time be rectified. Reynders's[10] apparatus (Fig. 49) consists of a pelvic band, *a*, steel dorsal splints, *b*, transverse bar, *c*, axilla-straps, *k*, and movable

lateral splints, *m*. A malleable iron head-piece is attached by straps, extending over the forehead and under the chin. This head-piece is provided with openings for the ears. It is connected with the spinal splint by an iron bar, *d*, which is divided into three joints, *efg*. These joints may be fixed at any desired angle. At *h* this iron bar fits into the spinal splint, and it may be held at the requisite height by the thumb-screw, *n*.

The Eulenburg-Langenbeck [11] apparatus (Fig. 50) may also

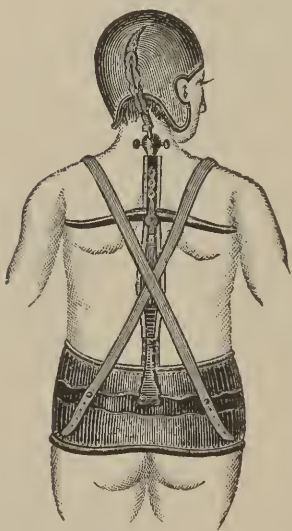

Fig. 48.—Mathieu's Torticollis Apparatus.

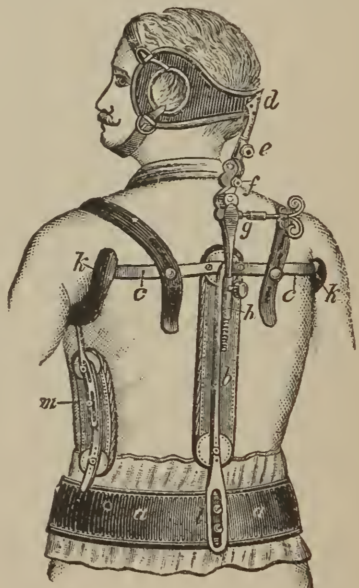

Fig. 49.—Reynders's Torticollis Apparatus.

be used after tenotomy, and by means of it the head may be maintained in any desired position. A large number of apparatuses aim at overcoming the contracture of the sterno-cleido-mastoid by means of extension of the head. An interesting apparatus on account of its marked simplicity is that of Petrali [12] (Fig. 51). It consists of three pieces of wood, one horizontal (C) and two vertical (AB). The vertical pieces are cut out to fit over the shoulders. This apparatus is attached to the body; two bands hold the chin upward; one band opposes rotation of the chin; a cravat-like band straightens the

curvature of the spine; another band pulls the head over to the side opposed to the contraction. Popoff's[13] extension apparatus is also useful in this connection, and it will be referred to under the subject of caries of the cervical vertebræ. Davis' apparatus consists of an arc-like frame fitting over the head and taking purchase on the shoulder toward which the head is bent.

Of non-ambulant apparatuses we would refer especially to the Esmarch extension bed. It is a slanting plane on which the patient is fastened by means of Glisson's slings. The

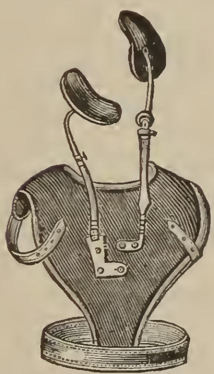

Fig. 50.—Eulenburg-Langenbeck's Apparatus.

Fig. 51.—Petrali's Apparatus.

patient may rest with relative comfort on this bed, being able to read, do hand-work, etc. He need not undress.

Délore and others recommend forcible reposition under anesthesia. The rotation of the head is accomplished by slowly increasing manipulations. When the aim has been secured the head is held in position by means of a silicate of soda bandage encircling the chest, neck and head. This bandage may be strengthened by the insertion of steel blades. In the majority of severe cases of myogenous wry-neck tenotomy or myotomy of the shortened muscle is the first step toward speedy cure.

In 1670 this operation was often resorted to by Roonhuysen. In 1822 it was first performed subcutaneously by Du-

puytren, and since his time it has been frequently done. In 1841 Dieffenbach recorded sixty-two cases.

By moving the head toward the sound side the operator determines which portions of the muscles are chiefly shortened. Occasionally, division of the sternal portion alone will suffice; again, both insertions or even other muscles must be cut in order to obtain correction of the deformity. The operation may be performed with the patient in the sitting posture, or lying down. Anesthesia is occasionally advisable. An assistant pulls the head over toward the opposite side until the insertion of the muscle becomes prominent. A second assistant may make downward traction by grasping the arm at the elbow. Usually both insertions of the muscle must be divided. The two incisions for this purpose are made about .7 of an inch above the border of the clavicle. When the division is made from within outward (Dieffenbach, Hüter, Sayre) a sickle-shaped tenotome is inserted on the flat under the tendon of the muscle until its point lies under the skin of the opposite side. In drawing the knife out the tendon or the muscle is divided by the point, the thumb of the operator making counter-pressure. The sudden yielding of the severed portion is evidenced by a snap.

When the section is resorted to from without inward a convex tenotome (Little's) is used. A fold of the skin is raised, the tenotome is thrust through this in front of the muscle, and the latter is divided by pressure on the back of the instrument. Many operators are opposed to this method on account of the risk of wounding a blood-vessel. Other operators recommend making a small incision by the bistouri, inserting a blunt-pointed knife through this incision, and dividing both the insertions of the muscle.

After the completion of the operation the wound is dressed antiseptically. For four to five days the patient must remain in bed, the head being maintained horizontally. Then the requisite orthopedic after-treatment must be resorted to. Klopsch, as early as the third day, applied permanent extension to the muscles of the neck by means of traction through an apparatus attached to the head. In this respect he imitated Stromeyer. Other operators deem it advisable to wait until the fifth day before resorting to orthopedic treatment. Fixation by means of cravat-like apparatus is, according to Klopsch,

Langgaard and others, insufficient. Such apparatus consists in a tight paste-board cravat which, being higher on the affected side, prevents the head from returning to the abnormal position. These retention cravats are more lasting if constructed of felt, metal (Mathieu), leather (Charrière[14]), or silicate of soda (Falkson[15]). Petersen begins treatment by accustoming the patient to the apparatus which he will be obliged to wear. When he can wear it for at least one hour three times daily, he performs myotenotomy. Two to three days afterward, the patient is subjected to treatment on the extension bed for two hours, thrice daily, and in the intervals he wears a Sayre cravat. In order to increase the traction force the ring of Glisson's sling may be attached more laterally over the iron brace, and thus the head is drawn over to a greater degree toward the healthy side. Port[16] resorts to elastic traction after tenotomy after the manner shown in Fig. 52. The thorax is encircled by a plaster jacket.

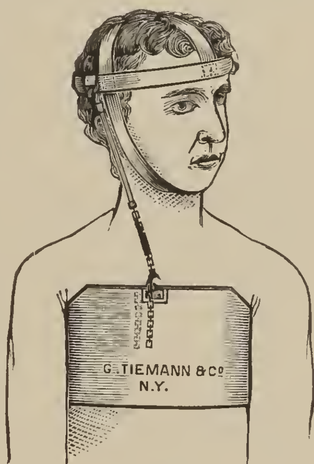

FIG. 52.

Special ambulant apparatuses are more frequently used. For instance those consisting of a jacket to which a jury mast and Glisson's slings are attached. H. Bigg, and others, have devised apparatus of this nature. The apparatuses which fix the head toward the healthy side, which over-correct the deformity, so to speak, are still more preferable: such as the apparatus devised by Richard, by Eulenburg, by Reynders, by König, etc. Occasionally, tenotomy of the sterno-cleido-mastoid does not suffice, and it becomes necessary to sever the anterior fibres of the cucullaris, or even of the levator scapulæ, when these fibres, after division of the sterno-cleido-mastoid, oppose reposition of the head. Dissatisfied with the result from subcutaneous myotomy in a number of aggravated instances, since new cicatricial bands formed in the deeper parts, which prevented reposition, Volkmann resorted to the following procedure: He laid the muscle bare by a large vertical

incision along its inner border, and severed it, as also the tense bands below it and in its neighborhood. In certain cases he even extirpated the fascia, etc.

The result in all the instances was good, union occurring by first intention. The after-treatment was relatively short and ended in permanent cure of the deformity. One of the most aggravated cases was an officer in active service. A number of surgeons, for instance Heinecke, resort to this method. It has the advantage of allowing the operator to control the steps of the operation, and the risk from hæmorrhage is far less.

Heinecke sutures the wound with catgut. He exaggerates the correct position of the head and maintains it by a paste-board bandage covered with silicate of soda, extending up to the ears and down to and around the shoulders. After fourteen days union is usually obtained and further treatment is unnecessary.

In spastic contraction of the sterno-cleido-mastoid, particularly, certain operators—de Morgan,[17] Wood,[18] Annandale—have excised a portion of the accessory nerve with good result.

In paralytic wry-neck, on account of the liability of the occurrence of secondary contraction of the antagonistic muscles, energetic electrical treatment and massage are indicated.

In case of cicatricial wry-neck, subcutaneous section of the cicatrices, or excision followed by precautionary measures against shortening, are called for. In instances of osseous wry-neck special apparatus must be resorted to, and of this we will speak under the subject of kyphosis of the cervical vertebræ.

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CHAPTER IV.

DEFORMITIES OF THE SPINAL COLUMN.

DEFORMITIES of the spinal column are of the greatest possible interest, owing to the frequency with which they occur and their great influence on the health and capacity for work of those affected.

For anatomical and physiological details I must refer to our text-books on physiology, in particular to the works of the brothers Weber, of Henke and Meyer, etc. I only desire to note here that the so-called physiological antero-posterior curvature of the spine present in adults does not exist in the new born. In the infant the spinal column is straight, and only gradually, after the child has begun to sit up, does the column uniformly curve backward. Later, under the influence of walking and standing, the pelvis becomes inclined, the lumbar spine curves forward, and gradually the two compensatory curves are formed, that is to say, convex curvature backward in the thoracic region, and convex curvature forward in the cervical and dorsal regions. This physiological curvature is of great importance, since the body thus acquires elasticity.

According to the direction of the curvature the following subdivisions are made:

Forward	curvature	is	called	Lordosis,
Backward	"	"	"	Kyphosis,
Lateral	"	"	"	Skoliosis.

These varieties of curvature are not always regular in one plane but are often very complicated. It is useful, further, to differentiate the curvatures from the flexions of the spinal column. According to the causal factors the division is made into congenital curvatures, which are rare, and into acquired curvatures, which are ordinarily met with. The latter are designated as curvatures due to habit, as static, traumatic,

pathological, etc., curvatures. According to the behavior of the curvature on suspension we speak of mobile and fixed or stationary curvatures.

Lordosis.

Lordosis is the rarest variety of antero-posterior curvature of the spinal column. The column is curved with the convexity forward, and the deformity is almost exclusively limited to that portion of the spinal column which normally projects forward, that is the neck and the lumbar region, in particular the latter. Lordosis of the cervical region is rare; it is very exceptionally congenital, and is usually due to muscular action.

Lordosis is frequently the result of the occupation of the individual. It is met with in people who carry weights in front of them; also in tailors, who, from the constant posture on their benches, acquire contraction of the ileo-psoas muscles, and this results, when the individual is erect, in lordosis.

All processes which lead to great obliquity of the pelvis may result in lordosis. Among such causes may be mentioned contracture of the hip-joints, large abdominal tumors, muscular paralysis eventuating in pathological increase of the physiological curvature. Busch [1] gives a marked illustration.

In the large group of compensatory lordoses we must mention those which are associated with congenital luxation of the hip, with pathological luxation of the hip, with contractures, etc. Here, owing to the great pelvic obliquity in standing and in walking, the upper surface of the sacrum approaches the horizontal plane, and the patient is thence compelled to bend his lumbar region forward and at the same time to hold the upper portion of his body backward.

Lordosis rarely attains the degree of fixation, in the paralytic form certainly not. In case of lordosis following on coxitis, etc., however, as a result of permanent unequal pressure, the vertebræ may gradually attain unequal height in front and behind, and then from anatomical alterations the lordosis may become fixed. In lumbar lordosis of high degree, ordinarily the retraction of the loins, the projection of the abdomen and of the gluteal region, are at once apparent. Examination in the dorso-recumbent position with flexion of the limbs, etc., will enable us readily to determine as to whether the condition is movable or fixed.

The treatment must be mainly prophylactic. In the management of the coxitis care must be taken to prevent permanent pelvic obliquity and angular contracture of the hip-joint.

Among the special therapeutic points we may mention suitable gymnastic exercises, the lying on the abdomen for a considerable time daily, frequent climbing of a steep ascent, etc.

The apparatuses recommended for lordosis consist generally of an abdominal band, two lateral axilla bands, and an elastic band which prevents the projection of the abdomen and of the lower part of the thorax.

Heather Bigg, by the insertion of an endless screw in the

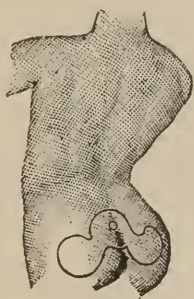


Fig. 53.

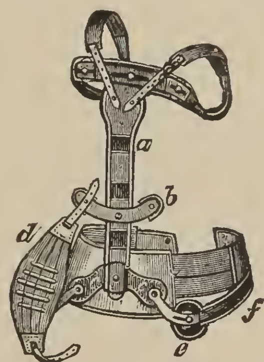


Fig. 54.—Nyrop's Lordosis Apparatus.

centre of the lateral splint, has enabled us to tighten at will the bandage which encircles the abdomen.

Nyrop's lordosis apparatus is readily understood by consulting Fig. 54. In Fig. 53 the purchase-point of the pelvic band is seen.

The apparatus consists of a steel spinal splint, *a,* with a cross-piece above to which the axilla straps are fastened. The pelvic band takes purchase through two pads, one of which is shown at *e.* To a cross-piece, *b,* is attached an elastic abdominal band, *d,* by means of which projection of the abdomen is prevented.

Kyphosis.

In the second variety of antero-posterior curvature, increased flexion in a segment of the spinal column leads to

backward curvature, to which, in general, the term kyphosis is applied.

It is useful to differentiate here the so-called round backs, from the pure kyphosis (flexion) which generally results from spondylitis.

The so-called round shoulders are met with in young people with relaxed ligaments and muscles, and the condition results from the habitual assumption of faulty position. Anxious mothers often deem this condition the first symptom of beginning deformity. In certain instances the entire spinal column above the sacrum presents a flattened arc with convexity backward. The scapulæ sink in forward and their apices stand out like wings from the thorax. In other instances the

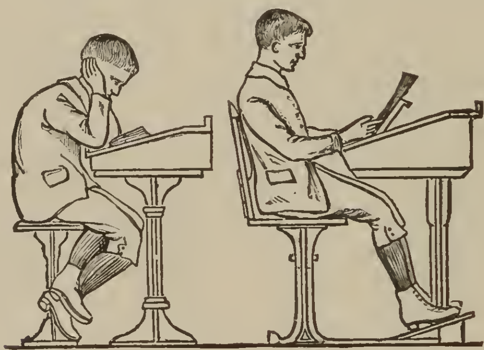


Fig. 55.—Faulty and Correct Position in Reading. (Roth.)

position is not assumed by the individual but the vertebræ are abnormally movable and the normal curve of the spinal column thus readily becomes exaggerated. The lateral contour is not asymmetrical and the scapulæ do not alter their position to the one side or the other.

As a rule, the greatest degree of curvature exists in the median portion of the dorsal region, which is tense, owing to the stretching of the muscles. Round shoulders are also found among adults whose occupation requires constant bending forward, and also in those who carry weights on their backs. Lane[2] has lately recorded a marked instance in an individual who in his youth was obliged to split wood. Here the antero-posterior curvature was so excessive as to give the appearance of a wedge.

Certain of the kyphoses met with in old people may be traced to their occupation. As a rule, however, kyphosis here results from senile muscular weakness and tissue atrophy.

A further variety of round shoulders is found in children from two to three years old who present evidences of rachitis. This variety is, in general, rare. It is not fixed, but disappears on the assumption of the horizontal position. It is due to great relaxation of the muscles and ligaments and to the softness of the bones.

The habitual carrying of the shoulders forward is a predisposing cause of lateral curvature. We must also refer to the kyphosis associated with osteomalacia; this form, however,

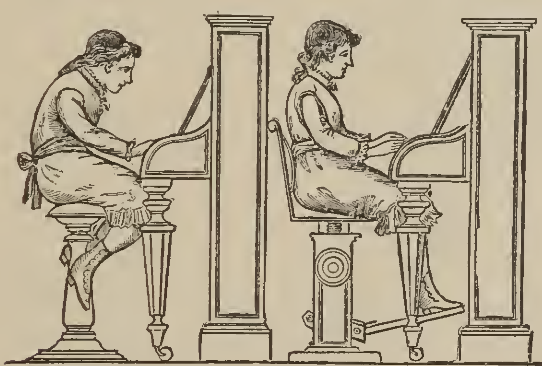


Fig. 56.—Faulty and Correct Position at the Piano. (Roth.)

is rarely seen purely in the sagittal plane and is ordinarily preceded by great pain.

The rachitic variety of round shoulders calls for anti-rachitic measures. The child should not be allowed to assume the upright position, but should be made to recline, as far as possible, on a good mattress. Nourishing food should be administered, the muscles of the thorax and of the limbs should be exercised. Cold bathing and rubbing are of value. For small children a gutta-percha splint shaped to the back and fitted with axilla straps, and a broad abdominal bandage is the most appropriate apparatus.

Older children require one or another of the many varieties of supporters. A suitable supporter must be provided with a pelvic band, and it should be constructed with two

vertical steel blades to extend up and down the back, as also with shoulder straps. Thus the required position is secured and the weakened muscles are suitably re-enforced. Staffel's apparatus is an excellent one. Heather Bigg and others have devised supporters which only control the shoulders and the pelvis, leaving the thorax and abdomen free.

Banning's apparatus (Figs. 57 and 60) takes purchase at the lower abdominal region through a pad, *A*. Two steel springs (*C*) pass over the iliac crests and obtain purchase at the gluteal region through two pads, *B*.

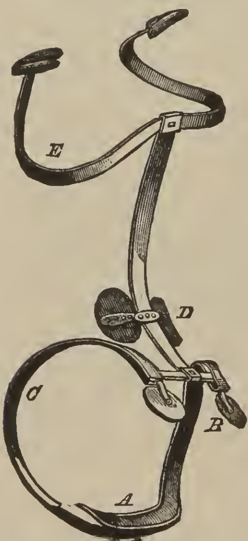


FIG. 57.—Banning's Truss.

FIG. 58.

All supporters which are not fitted with a pelvic band and those which, like the well-known Bouvier, simply extend between the shoulders, are worthless.

Corsets, lightly constructed and fitted with steel blades, are also suitable for the treatment of round shoulders, especially when straps for holding back the shoulders and neck are adapted to them. Nyrop's spring supporter consists of a pelvic band to which a posterior steel blade is attached. Above, this blade is connected with a cross-blade which carries the shoulder straps (Figs. 59 and 61). This supporter corrects the habitual anteflexion of the spinal column, and it is especially

valuable in that it does not compress the thorax, is light in weight and may be worn under the clothing without attract-

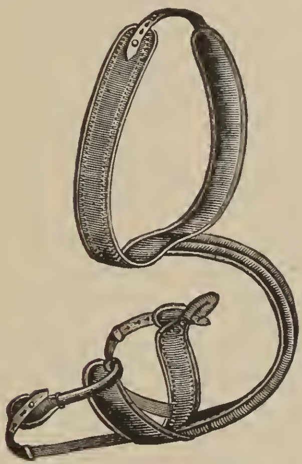


Fig. 59.—Nyrop's Supporter.

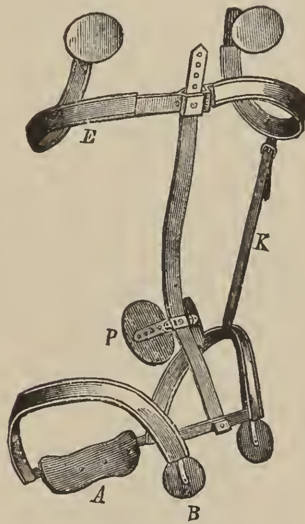


Fig. 60.—Banning's Supporter.

ing attention. The Stillman apparatus also fulfills well the indications, and it takes purchase on the sacrum.

The pathological variety of kyphosis is the result of caries of the vertebræ, as a rule, dependent on tubercular osteitis. The deformity is characterized by an angle in the spinal column, the concavity of which is forward. One or more of the spinous processes of the vertebræ project backward forming a hump. The bones are softened by the granular osteomyelitis, and the anterior portion of the bodies of the vertebræ sink downward under the weight of the body.

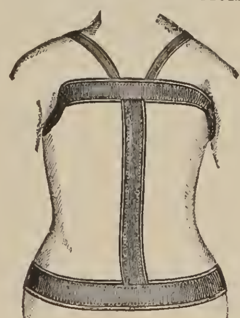


Fig. 61.—Nyrop's Supporter.

This disease was first described in 1783 by P. Pott, and it therefore bears his name, although the affection was known to Hippocrates, Galen, and others, and although Delpech and especially Nélaton had recognized its tubercular nature.

Although American writers (Bauer, Sayre, Owen, and

others) are inclined to consider trauma an etiological factor, even though the history yields no clue in regard to such an occurrence, there can be no doubt but that the affection occurs spontaneously without any determinable cause, and that weak children and those predisposed to tuberculosis are apt to become affected. The disease unquestionably develops in a tubercular soil, and can only exceptionally be traced to other diseases.

The disease may develop at any time of life, but it chiefly affects children from two to six years old. The infant is not apt to be affected and the disease is rare during the first year. After fifteen years it is very exceptionally met with. Nebel found only twenty-eight instances above fifteen years out of 225 cases. It may, however, develop in adults and even old age is not absolutely exempt.

Boys are, in general, much more likely to become affected than girls. Nebel [3] out of fifty-four cases found thirty-one male and twenty-three female.

In regard to the frequency of caries of the vertebral column we can offer the following statistical data: In 52,256 records of autopsies Menzel [4] found 702 cases of caries of the vertebræ and 238 cases of caries of the knee-joint; Nebel found 82 instances in 1,957 autopsies; Billroth states the percentage of vertebral caries as 35; König claims that this percentage is far too low.

As to the frequency of the disease in one or another part of the spinal column statements are very different. According to Billroth, the vertebræ are most frequently affected in the following order: the sixth dorsal vertebra, the second cervical, the fifth, seventh and eighth dorsal, the third cervical, the third, fourth, ninth and tenth dorsal, and next the fourth lumbar vertebra. According to Hüter [5] the eleventh and twelfth dorsal are most frequently diseased, and next the first lumbar vertebra. Nebel also states that the lumbar portion of the spine is most frequently diseased. In 183 cases Parker [6] found the cervical vertebræ diseased nine times, the dorsal eighty-two times, the dorso-lumbar twenty-one times, the lumbo-sacral thirty-seven times.

Kyphosis, then, in the vast majority of cases, is the result of a tubercular affection of the bones which either begins as a granular myelitis (granulation tuberculosis) [7] at one or more

places, thence spreads and leads to sinking of the affected portions under the weight of the body, or else it begins as a tubercular infiltration of the bone substance leading to a purulent osteitis. This latter form was described by Delpech and Nélaton under the name of tuberculosis of the bones. On section of the affected portion of bone it is found to be infiltrated with a yellow material. The surrounding bone tissue is hyperæmic and the two portions are separated only by a thin layer of tubercular granulations. (Fig. 62.)

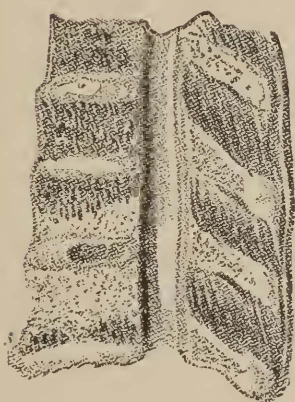


FIG. 62.—Osteitis Caseosa (Tuberculosa) of a Vertebra. (Cross-section.)

FIG. 63.—Spinal Column of a 4½-year old Child. Caries of the Tenth Dorsal and of the Second Lumbar Vertebra. *ab*, Carious remnant of the vertebra; *cd*, Kyphosis; *e*, Last rib. (After Paul.)

The affected bone may speedily break down, or else the tubercular sequestrum may remain latent for years, being surrounded by granulations. The inter-articular cartilage may become involved through extension of the granulation process, or else suppuration and necrosis may start in the cartilage and the process may thence extend to the adjacent vertebra.

Primary fungous inflammation of the vertebral joints is very exceptionally met with, and then ordinarily in the verte-

bræ of the neck leading to displacement in this region. When the upper cervical vertebræ are affected dislocation of the diseased joint, in particular the first, may lead to sudden death from pressure on the medulla.

The suppurative process is rarely widely disseminated superficially. In such instances the periosteum is undermined and many of the vertebræ are eroded, as it were, on the surface. Such is the case in actinomykosis. Usually the suppuration is more central. In an unexplained manner the process invades one or another neighboring vertebra. A cavity filled with granulations or with detritus is formed at the diseased locality, and when the bone substance surrounding this cavity is no longer able to withstand the pressure, the vertebra sinks in, its spinous process projecting backward. This is the beginning of the hump, which is of course the more marked the more extensive the caries of the body of the vertebra. Occasionally the epiphysis is destroyed and the process involves the apophyses and vertebral arches. Such an extension, however, is rare.

If the affected vertebra be macerated, then, after the granulations have been removed, we may readily inspect the cavity in the bone. The vertebra looks as though it were worm-eaten. Frequently only remnants of one or more vertebræ are left (Figs. 64 and 65), so that the number affected can only be estimated by counting the spinous processes. It is readily apparent why the softened body of the vertebra cannot withstand the pressure to which it is exposed. The point of union of the spinous processes remaining intact, the anterior portion of the affected vertebra sinks forward.

Without question there occur cases of spontaneous cure of caries of the vertebral column, especially where the process is superficial rather than deep. The pathological granulations are replaced by healthy; these latter ossify and lead to a species of bony union. In other cases the formation of a marked gibbus is counterbalanced as follows: The inflammatory process leads to the formation of osteophytes in the neighborhood. These coalesce and bridge over the diseased portion of the spinal column, thus yielding an efficient support and preventing additional deformity.

In the vast majority of cases, however, an abscess results from the extension of the destructive process. The pus infil-

trates the neighboring parts, and eventually a large abscess cavity is formed. Since the anterior vertebral ligaments constitute a barrier in front, the pus sinks downward through the loose cellular tissue until it appears at certain determined spots as the so-called cold abscess. This abscess gradually increases in size: it may remain latent for long, or it may quickly spread toward the skin, and, if the knife is not resorted to, it breaks externally, the air enters the large cavity which is covered with the fibrinous, so-called pyogenic membrane, and the patient may speedily die of sepsis. According to Taylor abscesses develop in 14 per cent. of cases of kyphosis.

König and Henke,[8] Soltmann and others, have pointed out how in the dissemination of the pus to form an abscess the loose cellular tissue offers no obstacle while

FIG. 64.—An Instance of Cure of Caries of Cervical Vertebræ. Three Vertebræ are merged into one. Slight amount of Interstitial Tissue remaining.

FIG. 65.—Macerated Specimen. Entire Destruction of a Dorsal Vertebra. Ultimate Anchylosis of the Apophyses.

the fascia and the aponeuroses do. The abscess rarely breaks through the latter. The pus sinks by gravity in the direction of the least resistance and it points at certain characteristic places. Pus from caries of the upper cervical vertebræ gravitates along the pharynx. It pushes the mucous membrane forward and it forms what is known as the retropharyngeal abscess. Such an abscess is of special importance, since it may readily lead to dyspnœa and dysphagia. Its sudden rupture may cause death.

Pus from the dorsal vertebræ, as a rule, gravitates through

6

the aortic hiatus into the abdominal cavity. It then follows the course of the psoas muscle, occasionally leading to suppuration of the muscle. It passes under Poupart's ligament through the inguinal ring and points in the upper part of the thigh, as the so-called ileo-femoral abscess. Exceptionally the pus travels along the psoas muscle into the abdominal wall and points in the inguinal region (Fig. 70 *a*), or else it sinks into the scrotum and there simulates a hydrocele or an inguinal hernia.

In other instances the pus passes along the iliac fossa into the cavity of the pelvis and travels outwardly along the ischi-

Fig. 66.—Purulent Remnants in the Middle Dorsal Vertebræ. Notwithstanding the marked kyphosis the spinal cord was not compressed.

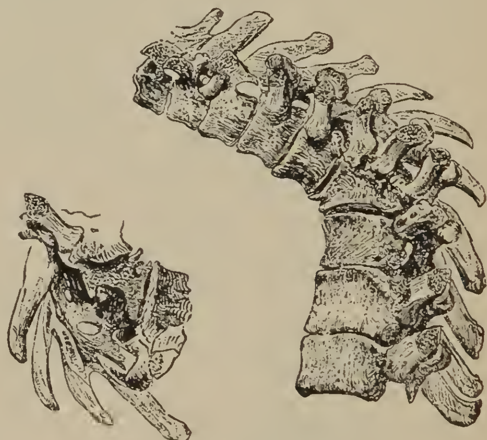


Fig. 67.—Complete Bony Union in a case of Vertebral Caries. Three dorsal vertebræ fused together. (Reduced ⅓.)

atic muscle through the major ischiatic foramen. The gluteal fold becomes effaced, a tumor forms in this region and an ischio-femoral abscess exists. Seeing that flexion of the hip may be associated with this abscess coxitis is simulated.

Exceptionally pus from the cervical and upper dorsal vertebræ travels down and points in the axilla, or else it travels along the ribs outside of the pleura pointing in the thoracic walls. Or, further, it penetrates between the muscles of the back and presents there as a fluctuating tumor. Rarely does the pus penetrate the pleura and form an empyema.

These abscesses may also rupture into the intestine—into the duodenum, the colon, the rectum, or into the bladder.

Owen has directed attention to the fact that *fistula in ano* may follow from rupture of an abscess resulting from vertebral caries.

In kyphotic patients there are also present disturbances from the side of the muscular system. So-called counter-curvatures are developed, especially a lordotic curve of the cervical vertebræ. Gradually this curve becomes a permanent one and the position of the head characteristic of severe instances of kyphosis results. When the seat of the affection is in the dorsal region the framework of the thorax collapses, as it were, through the sinking together of the vertebræ. Occasionally the ribs approximate one another so closely as to come into contact. In disease of the lumbar region the lower ribs sometimes project over the pelvis or sink down into the iliac fossa. In general the ribs are lifted upward, the sternum projects like a keel (chicken-breast), the vertical diameter of the thorax is markedly lessened and congestive and pressure symptoms are in consequence present.

The concurrent symptoms from the side of the spinal system are above all of importance. Frequently the nerve bundles, which pass through the intervertebral foramen, seeing that they lie imbedded in infiltrated or hyperæmic or suppurating tissue, take part in the disease process. It is often astonishing how the spinal cord escapes alteration notwithstanding kyphosis of high degree. As a rule the membranes of the cord near the diseased region are thickened and callous. Peripachymeningitis results. The pus may perforate into the spinal canal, or the disease may extend to the substance of the cord itself through implication of the membranes.

In a certain proportion of cases, especially when the hump forms quickly, the spinal cord suffers directly from compression. A so-called compression myelitis develops, and the degeneration may extend above and below (Turk), giving rise to the so-called secondary degeneration. This degeneration is characterized by disease of the posterior fibres above the spot of softening, and of the lateral fibres, in particular, below. Macroscopically this disease is evidenced in the fresh specimen by a grayish, transparent, pale yellow appearance, and microscopically, after staining, we may find fatty degeneration of the nerve bundles and interstitial increase of the cellular tissue.

Exceptionally the spinal cord is compressed by the projection of an abscess inward.

The symptoms of implication of the spinal cord may be varied, such as slight contractures, paræsthesiæ, pareses, even complete paralysis. The paraplegia will be extensive according to the seat of the disease, and cystitis, decubitus and other affections may be the sequelæ. The reflex symptoms are usually greatly exaggerated. The triceps-reflex is often obtainable.

A further important sequela of kyphosis, when the seat of the disease is in the lumbar region, is alteration in the shape of the pelvis. For information in regard to the kyphotic pelvis we must refer the reader to text-books on obstetrics.[9]

Fig. 68.—Traumatic Dorso-lumbar Kyphosis in a Man aged 30.

More infrequently still than the tuberculosis of the bones (spondylitis) of which we have spoken, may tumors (sarcoma, carcinoma) of the spinal column, gummous osteitis accompanying general syphilis, and possibly actinomycotic changes lead to kyphosis, or else the disease may develop more gradually as the result of trauma (Fig. 68). Fracture, associated with comminution of the body of the vertebra, the processes remaining intact, may eventuate in kyphosis.

As regards the symptomatology of the disease, the premonitory signs are characterized by the individual becoming readily tired, by intercostal and lumbar neuralgias, by stiffness of the vertebral column in walking or other motions, etc.; often the child simply shows a disinclination to play, has an anxious look, and is careful not to move the vertebral column in ascending stairs, in jumping, etc. The most marked symptoms are the deformity, the formation of the hump, the accessory phenomena from the side of the spinal system and the gravity abscesses.

Often the sudden crying out of the child during the night, or grinding of the teeth, or a deep-lying pain in the epigas-

trium, are the first symptoms leading us to suspect disease of the vertebral column. Then the rubbing of the column with a hot sponge (Copeland) may reveal sensitiveness of the affected vertebra, or else pressure on the spinous processes may result in causing marked pain. Occasionally the formation of the gibbus is evidenced by projection of the spinous process of the diseased vertebra when the patient bends forward. The deformity is especially apparent in the dorsal region as a projecting knob which gradually becomes evident and attracts the attention of the parents. Very rarely the deformity appears suddenly without premonition, and in these acute cases the spinal symptoms in particular predominate. Such symptoms are often not marked to a surprising extent in instances of long forming, although aggravated kyphosis. The motor nervous system is naturally less severely implicated, and, according to the seat and the extension of the disease, we may determine only slight paresis of certain muscle groups, a certain difficulty in motion, or entire paraplegia or total paralysis of the parts lying below the disease centre. Weakness of the sphincters up to complete paralysis of the rectum and bladder frequently form the sad accompaniments of aggravated kyphosis.

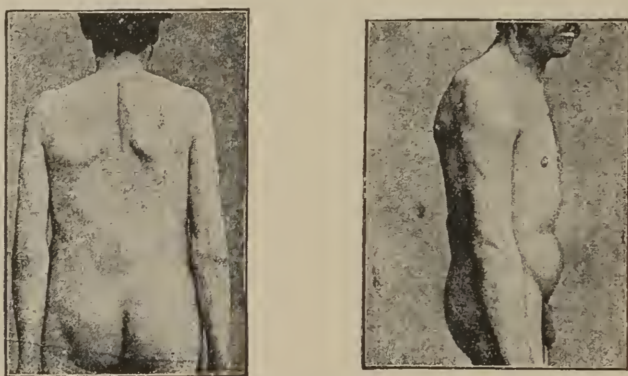

Fig. 69.—Fixation of the Vertebral Column in Bending.

When there exists a suspicion of caries of the spine the child should be entirely unclothed and then examined. It is of the greatest possible importance to make an early diagnosis, for thus the extension of the disease may be prevented.

Parasthesias of slight degree, sensation of constriction, anæsthetic zones, weakness, etc., such symptoms should direct the attention of the physician to the spinal column, especially if, in addition, the subject becomes readily tired and is averse to movements. We may often obtain an absolute diagnostic symptom of disease of the vertebræ by making the child bend forward and noting how the act is performed with the spinal column held rigid (Fig. 69), and, next, how the erect

position is reassumed purely by extension of the lower extremities. Often these patients rest their arms on the thighs in order to lessen pressure on the diseased surface, or else they avoid standing or walking as much as possible.

In children, as a rule, the disease progresses rapidly to the formation of the gibbus, while in adults the affection frequently exists for a long time without angular kyphosis, and the disease of the vertebræ may be readily mistaken for other affections. In aggravated instances with marked gibbus, or where abscesses or symptoms from the side of the cord are present, the diagnosis offers no difficulties, while in the beginning the disease may be mistaken for coxitis, or for hysterical



FIGS. 70 and 70 a.—Lumbar Kyphosis. Front and Profile View. Beginning Abcess above the Crest of the Ilium.

manifestations, or for disease of the cord, etc. This holds true in particular for adults, where the affection is apt to progress slowly before the characteristic deformity appears. In case of coxitis it should be noted that the contracture is not a simple one, as in that accompanying spondylitis, but it is combined either with abduction and outward rotation of the limb or else with adduction and inward rotation.

As regards disease of the vertebræ of the neck the deformity, as a rule, appears somewhat differently. Often we can only determine a thickening on one side of the neck, a bending or drawing of the head. Eventually the abscess appears laterally in front of the cucullaris muscle and it ordinarily breaks through the supra-clavicular fossa.

Kyphosis in the neighborhood of the last vertebra of the neck may readily be confounded with the normal projection of the *vertebra prominens*. Frequently torsion of the neck toward the healthy side results. (Torticollis oss.)

In order to determine beginning abscess formation it is requisite to look for the following symptoms: Deep-lying neuralgic pains, pain on pressure, swelling, distention of the veins, œdema, etc., in the affected region, and, in particular, we must

FIG. 71.—Kyphosis of the Upper Dorsal Vertebræ.

FIG. 72.—Kyphosis in the Lower Cervical Vertebral Region. Wing-like Backward Projection of the Scapulæ.

FIG. 73.—Tracings of Varieties of Kyphosis. (N. Smith.)

examine the iliac fossæ when the patient is in the dorso-recumbent position with flexed limbs.

It is often essential to obtain a tracing of the kyphotic projection, in order to follow the successive changes. For this purpose a strip of lead molded over the vertebral column will answer, or we may use one or another of the apparatuses which will be described under the subject of skoliosis.

The progress of the disease leading to kyphosis is usually chronic and rarely acute or sub-acute. Where the affection runs an acute course it is associated with febrile phenomena

and may end in death before the deformity appears. In children, as we have stated, the progress is ordinarily more acute and in a few weeks a very marked gibbus may form. In adults years may elapse and numerous abscesses may form before the appearance of the characteristic deformity. We may frequently differentiate a number of stages in the progress of the affection: 1. The stage of onset where the symptoms are not specially marked; 2. The stage of characteristic gibbus; 3. The stage of suppuration and of paralysis. The disease does not always progress to the latter stage. In many instances, after two to three years' course, we rather find the vertebra again solid through a species of ossification, and a cure results. This may happen at any time, even after abscesses have formed. Even spontaneous resorption of abscesses has been noted. This, however, is infrequently the case.

The prognosis of the disease is, in general, unfavorable. The old saying of Hippocrates "*qui gibbosi ex asthmate et tussi fiunt, ante pubertate moriunter,*" refers to the high mortality rate from tuberculosis of kyphotic children (Busch), and it is certainly true that a large proportion of those affected succumb to miliary tuberculosis, amyloid degeneration, etc., and that even where the local process becomes arrested there remains a tendency to emphysema and above all to lung and to heart diseases, and therefore the affected individuals rarely reach middle age. Formerly the abscesses often endangered life and true enough the modern treatment of these accumulations of pus has bettered the prognosis a trifle; the symptoms, however, from the side of the spinal cord, always modify the prognosis, for, after an interval of many years, we often witness the development of paralysis, and when once symptoms of compression and of paralyses have appeared (particularly from the side of the bladder and of the rectum) the clinical picture becomes a very sad one, decubitus, hypostases, etc., soon form and end the scene. The higher the seat of the disease, the more extensive the process, the more unfavorable the prognosis, which, of course, also depends on the general constitutional strength, on the concurrence of affections of the lungs, etc. As regards the subject of treatment we must differentiate the general from the special mechanical.

It should be the endeavor to re-enforce the general health

as far as possible by means of suitable food, preparations of iron, cod-liver oil, sea-baths, fresh air and sunlight.

In an early period of the affection cold applications to the spine by means of ice-bags (Chapman), are very valuable, as proved by Esmarch's and Eulenburg's experience. ' Hueter recommends the injection of carbolic acid in the neighborhood of the diseased vertebra or deep injections of a solution of corrosive sublimate. It was formerly the custom to depend to a great extent on derivatives (Pott, Rust). To-day these agents have been rejected, although latterly fly-blisters have been extolled by a number of gentlemen, for example by Busch.

The chief indication in the treatment of caries of the vertebræ is the fixation of the spinal column and the removal of pressure from the anterior portion of the vertebra, that is to say we must seek by means of rest to prevent irritation of the affected part, and our aim must also be as far as possible to remove pressure from it. It is in these directions that modern practice has chiefly excelled, and especially in that attempts at forcibly straightening the spinal column have been condemned.

Formerly, the chief indications were deemed to be the keeping of the patient in the horizontal position and the forbidding of the assumption under any pretext of the erect posture (Eulenburg, Baum, Noble Smith, and others). Bauer, for instance, recommended the horizontal position on a water bed: others have commended keeping the patient lying on the abdomen on a suitable bed—the prone system of the English (Harrison, Bampfield, Knorr). Others have extolled the lateral position. Noble Smith[10] claims that the advantage of the abdomino-recumbent position is that pressure is thus taken from the diseased part and the unfavorable traction of the muscles on the anterior portion of the column is prevented. He does not believe that there is thus risk of the pus gravitating forward. Such methods, however, cannot be carried out without injury to the general health, and in any event harm may result from uncontrollable movements of the patient.

In a proportion of the cases, especially in infants, the dorso-recumbent position on a good hair mattress must be considered the best procedure. Apparatus (Volkman, Kappeler) for preventing involuntary movements on the part of the patients, a matter of the greatest possible importance where the dis-

ease affects the vertebræ of the neck, can certainly only be used in children who are old enough to be taught the necessity of restraint. Such apparatus may act either through counter-extension by weights or through elastic traction. The patient is placed horizontally on a hard mattress. Extension is obtained by the following mechanism: To a collar around the patient's neck a stout string is attached which passes over a roller on the top of the bed and carries a weight of from four to six pounds. The weight of the body yields the counter-extension. In case of caries in the dorsal or lumbar region traction may also be made from the axillæ.

Where the disease is located in the middle portion of the spinal column Rauchfuss' suspension girdle [11] may be used. By means of it pressure is removed from the diseased portion, and the requisite degree of traction is readily obtained by lowering or raising the girdle. This girdle is drawn tightly transversely over the bed under the affected portion of the spine and direct pressure on the gibbus is avoided.

For the median portions of the spinal column it is possible to utilize the weight of the body for purposes of distraction through Rauchfuss' suspensory belt. This is a broad belt stretched across the bed, which can be applied with special facility to the ordinary children's slat beds, and on which the affected portion rests; the amount of stretching can be easily regulated by higher or lower suspension of the belt. Pressure on the gibbus can be readily avoided by cutting out a corresponding segment from the belt. The difficulty of fastening the child sufficiently to the belt, which seems to reduce the value of the apparatus in the eyes of some (Nebel, Koenig), has been overcome by Schildbach's modification.[12]

This belt (1½ to 3 inches broad according to the age) is fastened to the sides of the bed and hangs in a curve. Schildbach attached to its two ascending portions two cross strips, the ends of which are fastened over the body of the child, thus fixing it, while two lateral cushions relieve the pressure on the gibbus.

Koenig employed for fixation a close-fitting jacket with sleeves and thigh-pieces which are fastened to the dorsal belt.

Reyher recommended a broader belt (7 inches), together with shoulder and perineal belts for fixation.

Mass [13] devised a simple and convenient way of relieving

weight and exerting extension by placing the patient on roll-pillows.

By causing the patient to recline over suspensory belts or rolls, we may usually attain rapid relief from pain and we

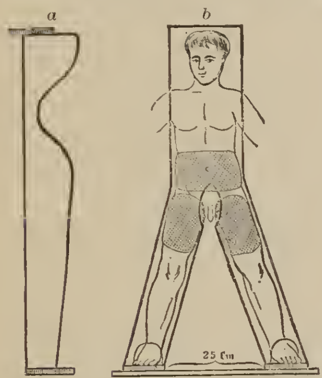


Fig. 74.—Phelps' Upright Bed (schematic); *a*, Lateral; *b*, Front View.

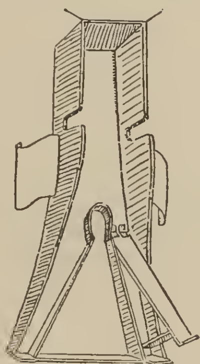


Fig. 75.—Upright Bed with Movable Leg-rests.

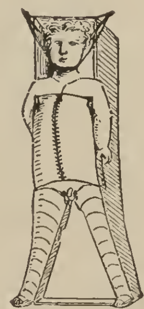


Fig. 76.—Upright Bed containing patient.

may exert a favorable influence on the deformity. These procedures are simple and, in tractable patients, are very effective.

One application of the principle of extension which can always be easily and cheaply resorted to, is the upright bed

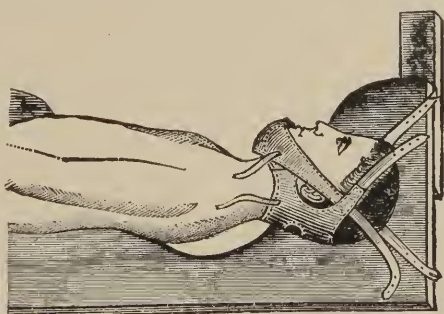


Fig. 77.—Fastening of the Head to the Upper End. (After Nebel.)

devised by Phelps (Figs. 74 to 77), and it is an apparatus of great value in infants, particularly for paralytic cases, and for those where there exists marked curvature.

By measuring or by making an outline drawing of the child with legs spread apart, we may have constructed a wooden case with openings for the arms (Fig. 75) and for defecation;

the foot-board must be about $5\frac{1}{2}$ inches high, and places for the heels are cut out, while the top of the bed is only closed at the posterior half by means of a slat. The case is then padded on both sides and especially across the middle with jute cushions; the padding (Fig. 74) is covered with water-proof material, the child is laid into the case and fastened with flannel roller bandages; the head is covered by an ordinary cap or rests in Glisson's slings, the straps of which are hung to nails on the lateral wall of the case. When the case is lifted and placed nearly or quite upright, the child is, as it were, suspended partially by the head.

As a rule, children with spinal caries are bedded afresh about once a week; the legs should be bandaged anew every day and be subjected to passive motion.

Portable kyphosis machines, in their simplest form, consisted of fixation by dorsal splints (the old cross of Heister) or of firm dorsal shields to which the pelvis and thorax were fastened, as in the wire cuirass of Bauer, the Volkmann half-cuirass of rubber, etc.

At an early period apparatus was devised which supported the spinal column through axilla crutches or braces; soon, in order to obtain vertical extension, Le Vacher [14] added a suspender for the head to the supporting apparatus (an appliance which, after having long been condemned as dangerous, has now again found general application in the shape of Sayre's jury-mast). These extension bandages with dorsal splints and Le Vacher's suspender for the head for a long time represented the chief means of treatment.

Then Taylor pointed out that a bent stick, which may be taken to represent the kyphotic spine, can be straightened not by extension, but more appropriately by being bent over a fulcrum placed at the point of flexion; and he applied this principle by means of a bilateral padded splint, acting as a lever, and casing dorsal flexion of the anteriorly curved spine.

It soon became evident, however, that Taylor's machine, which will be more fully described below, acted mainly as an immobilizing dorsal splint (Hueter, Vogt [15]), that the correction was only apparent, and P. Vogt noted in numerous children that the apparent over-correction of the anterior inclination was due solely to a lordotic flexion of the neighboring spinal segments, while the kyphosis persisted unaltered. He

therefore modified Taylor's apparatus by the addition of means for the removal of pressure from the spinal column. He effected this by adding lateral arms with axilla crutches to the splint at the level of the shoulders (occasionally also adapting lateral braces to the pelvic belt), and for the support of the head he added a steel collar covered with leather and united to an extension from the dorsal splint.

All these appliances must be carefully watched; they can only be made by a mechanic, their construction takes time, and they are expensive. It is apparent, therefore, that a

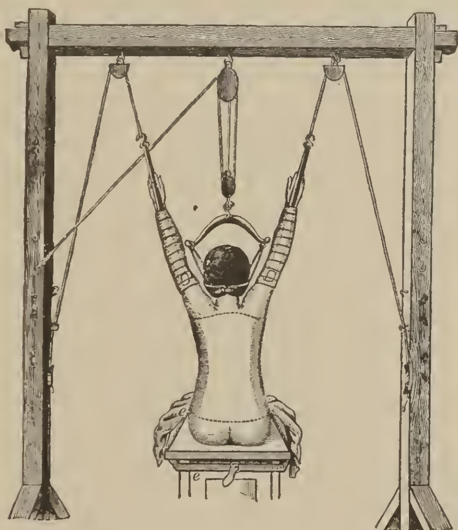


FIG. 78.—Suspension for the Application of a Corset. (After Beely.)

method applicable to the routine needs of every physician was bound to find rapid and general recognition, and for this reason Sayre's method of treatment by the corset and suspension spread quickly and proved valuable everywhere. Reports from numerous clinics (Esmarch, Madelung, Nebel, etc.,) certify that the plaster-jacket method of treatment is one of the handiest, most certain, and cheapest means of fixation. By an early application of the plaster jacket it is usually possible to forestall the occurrence of permanent deformity, and frequently to prevent the formation of gravitation abscesses (Nebel[16]). By means of this method we undoubtedly give the

patient great relief, mitigate his pains, and frequently effect a cure.

Sayre's method can be employed for caries at almost any point of the spine, and neither gravitation abscesses nor bed-sores are contra-indications. It is hardly possible to lay too much stress upon the fact that thereby we do not aim at *brisement forcé,* or obliteration of the kyphosis, but that we try to circumvent the injurious influence of weight and mus-

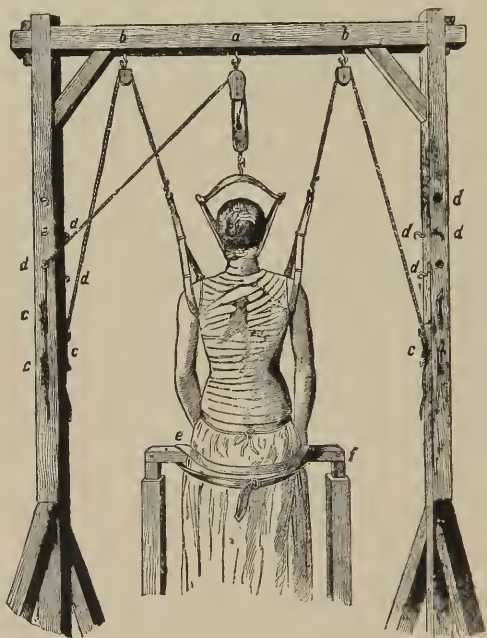


FIG. 79.—Suspension for the Application of a Plaster Bandage.

cular traction by careful, gentle suspension, simply sufficient to lessen the pressure on the affected parts, the toes never leaving the ground. Sayre lays stress on the point that the suspension must be gradual, and that we must never go beyond the point at which the patient feels entirely free from pain. The plaster jacket is applied as follows:

Everything necessary for the plaster dressing having been prepared (good modelling plaster, starched gauze bandages into the meshes of which plaster has been rubbed, dishes with warm and cold water, cotton, etc.) and the patient having

been dressed in a seamless stockinet jacket, the head is fastened in Glisson's suspender, due care being taken that the chin strap does not slip, the body being at the same time supported by axillary rings (Fig. 78) in Sayre's tripod (or by a hook in the ceiling) by means of pulleys, so that the patient still touches the floor with the tips of the toes. Then we insert under the stockinet jacket, which is tied over the shoulders, a pad of wadding ("dinner pad") over the region of the stomach; the mammary glands and the crests of the ilium are protected by pads, and small felt bolsters are placed on both sides of the gibbus (Madelung). Then, commencing at the pelvis and winding upward until we reach the axillæ, the trunk is surrounded with plaster bandages, avoiding folds. A fresh bandage is placed into the water to soak only after removal of the preceding one. While bandaging, the physician stands preferably behind the patient, while one assistant kneels in front, holding the legs to prevent rotation, and another at the side holds the cord and hands the moistened bandages.

Usually it is sufficient for the corset to extend upward a little higher than the nipples, covering half the shoulder-blades. In case of dorsal or cervical kyphoses, the jury-mast must be included in the plaster dressing. (In children, as a rule, five to six plaster bandages about 13 feet in length and $3\frac{3}{4}$ inches in width will suffice; occasionally, the back of the bandage may be strengthened by chips of veneer, etc.)

The patient must not be taken out of the suspensory apparatus and laid horizontally on a mattress until the plaster has set, and then the dinner pad is removed and the dressing is cut out somewhat at the axillæ, etc., if necessary.

The application of the plaster jacket with the patient in the horizontal position, as recommended by Walter, Willet, and others, has been tried more especially by Petersen;[17] the head and pelvis of the reclining patient are supported, suspension being obtained by a bandage carried around the gibbus, and in this position the plaster dressing is applied.

When no special indication arises for its removal, the jacket may be worn for from three to six months. If the jacket is constructed so that it may be removed at will, its effectiveness is partially nullified, and this is allowable only for slight cases near recovery. The removal of the jacket is greatly facilitated by including in the front of the dressing a strip of

leather, which is divided after the plaster has set, and if perforated with holes on both sides can be made to lace. Roberts added anterior metal clamps for the purpose of removal (Fig. 80).

Fig. 80.—Roberts' Corset with Central Clamps.

A number of modifications aim at making the plaster jacket in several layers and to include extension apparatus (Stillman, Wyeth, etc.). Wyeth [18] recommended that the jacket be made in two pieces, with extension screws passing through nuts fastened in the dressing, thus allowing separation, the intervening part (gibbus) being bound moderately tight with a roller bandage. During the night the posterior rod can be removed, the two lateral sufficing when the patient is in the horizontal position (Fig. 81).

Similarly, Roberts [19] has devised a means of extension in connection with a double plaster jacket, including four supporting clasps of perforated sheet copper (Fig. 9); a corresponding number of iron rods with screws and spiral springs allow of gradua-

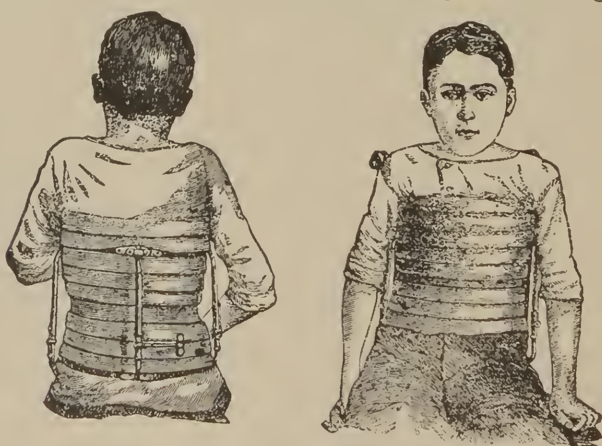


Fig. 81.—Wyeth's Double Corset with Extension Rods.

tion of the spring pressure. This modification can also be used for the correction of a co-existing lateral deviation, by connecting two of the iron rods by a rubber cord or adding another clamp on the side opposite the deviation, the rubber cord passing along the outer side of the corresponding extremity and being fastened to the shoe (Fig. 82).

For cervical kyphosis, in particular, the ambulant apparatus requires a number of additions, in order to relieve pressure

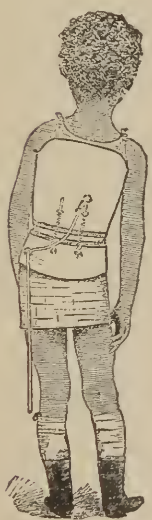


Fig. 82.

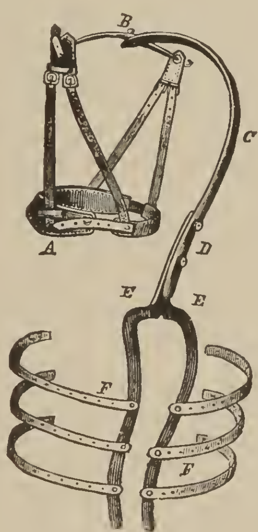


Fig. 83.—Jury-mast.

Fig. 84.—Jury-mast. (After Nebel).

and to provide extension: this has been effected by a number of appliances included in the plaster jacket, etc., thus, for instance, in Berger's method, reported from Thiersch's clinic, "the bridge plaster dressing" consists in a plaster jacket inclosing the shoulders, from which extend two lateral iron bands with proper curve, which are fastened in a plaster dressing applied around the occiput and forehead. The jury-mast (Fig. 83) consists of a two-tined fork, *E*, of soft iron, which carries above (corresponding to the handle) a movable, solid, more unyielding rod, *C*, which projects over the head

and in front to about a line uniting both ears; to this is fastened a cross-piece which can be rotated around a rivet, *B*, and which carries at its two ends small hooks for the suspension of the head-piece, *A*. The iron blades constituting the prongs of the fork are curved to fit the back, and are provided at the sides with two or three narrow brass hoops, *F*, which almost completely encircle the thorax, and are perforated like a grater, so as to give hold to the plaster bandage.

In using the jury-mast, the patient is first wrapped in the usual manner with a few turns of plaster bandage, care being taken that the bandage surrounds the thorax smoothly; the jury-mast, properly surmounting the head and in the sagittal plane, is next placed in position, and the apparatus is fastened by additional turns of plaster bandage, the assistant carefully moulding the bandage into all the depressions caused by the apparatus.

Morris (New York) has devised a very cheap substitute for the jury-mast. It is made of iron wire the thickness of a lead pencil. This is bent to the proper shape, and the parallel wires are fastened at equal distances by brass bands soldered on and reinforced at the points of greatest curvature (thus securing elasticity), small square hooks soldered on serving for the suspension of the head-piece (Fig. 84).

In regard to other apparatus resembling the jury-mast we may mention Roberts' elastic traction head-rest, which does away with the annoyance of the jury-mast extending over the head, which is objectionable to many. It consists of an upper cervico-mental collar, with metal clamp under the chin, so that it can be applied and removed with ease. To this the body-piece is fastened by means of lateral coiled springs and a hinge-joint. This trunk-piece can be moved longitudinally and placed at any desired point in the sagittal plane by an endless screw. The lower forked part of the apparatus is inclosed in the usual manner in the plaster dressing.

W. Pye,[20] in many cases of kyphosis of the upper dorsal vertebræ, incloses in the plaster dressing a dorsal splint instead of the jury-mast; this splint is forked below, so as to avoid pressure on the diseased parts. Above, it reaches only to the occiput, and at its free upper extremity it bears two transverse rods (one at the upper end, one at the height of the first dorsal vertebra). To the former arm-slings are at-

tached, to the latter slings of stout material for the thorax and abdomen, which are included in the plaster dressing and thus counteract the tendency to bend forward.

Although there is no doubt that the plaster dressing is one of our most important therapeutic agents, on account of its cheapness, facility of construction, slight weight, and non-interference with taking exercise, we must remember the disadvantages of the method, pointed out, for example, by Smith

FIG. 85.—W. Pye's Modified Jury-mast for Upper Dorsal Kyphosis.

FIG. 85 a.—The Same Apparatus after Fastening the Slings.

—*viz.*, the impossibility of watching the morbid process and of determining when it is necessary to remove the jacket; further, the facts that perspiration is interfered with, that vermin may lodge in the bandage, and especially the fact that it interferes with the development of the thorax when it is worn several months. For these reasons the exclusive use of the method has been largely abandoned.

The material from which the jacket may be constructed has been modified. In order to secure greater durability, the

jacket has been made of silicate of soda—a method recommended among others, especially by Wolff, Fowler,[21] Kölliker,[22] and Witzel. The silicate of soda is preferable to any other material on account of its lightness, its durability and cheapness, and particularly because the jackets can easily be made in a removable form. According to Kölliker, the silicate of soda should be applied with the patient suspended, the heels slightly raised from the ground, the traction acting mainly on the head; flannel bandages are first applied, then four to six layers of silicate bandages, which must not be too moist, lest the flannel become saturated. Strips of veneer are included in the dressing at the upper and lower edges, in each axillary line, and laterally at the spinous processes to reinforce the bandage. A temporary plaster dressing consisting of three to four bandages should be applied over all, to keep the silicate bandage in position until it has hardened (two to three days). The patient must remain suspended until the plaster has set (Wolff).

For cervical spondylitis, silicate of soda bandages surrounding head, neck, and trunk, and fashioned over a plaster cast, have been much employed in Schonbörn's clinic (Falkson[23]). They are made to lace by covering the edges with strips of linen having hooks sewed on, and are lined throughout with flannel.

Besides plaster of Paris and silicate of soda bandages for spinal deformities, use may be made also of simple starch-paste bandages with pasteboard shaped to fit the back, and saturated with shellac, and strengthened by pieces of linen.[24] The old and now almost obsolete glue dressings for making soft corsets with firm dorsal shields can be used to advantage, especially for poor patients, being cheap and durable, and the necessary material being everywhere obtainable.

Smith,[25] Braat, and Karewski[26] employ jackets made of woven wire shaped over the patient's body or a plaster model; they are tinned, to preserve them against rusting, and the jury-mast can easily be added to them. They possess greater durability and cheapness than the other appliances, and they can be used for cases of inferior lumbar kyphosis, where the patients are confined to the bed, by adapting splints reaching to the knees and by leaving openings for urination and defecation (Karewski).

Touvers[27] and others recommend a leather jacket shaped

over a cast, to which a jury-mast can be readily applied and which may be made removable. Mathieu also employed leather (strengthened by flexible steel springs) for corsets shaped over casts, but they were too dear to find general application. H. Bigg's leather corset, however, with elastic material over the chest and abdomen and lined with soft leather, is a very durable apparatus, which gives suitable support and which does not interfere with respiration.

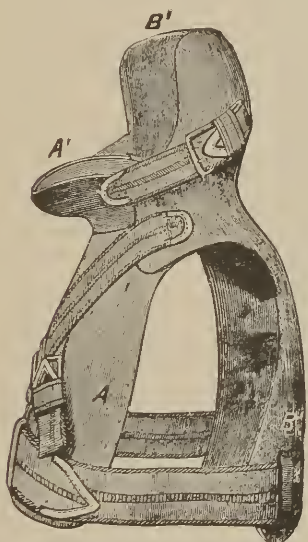


FIG. 86.—Owen's Stiff Leather Cuirass for Caries of the Cervical Vertebræ. *A*, Anterior; *B*, Posterior Plate; *A'*, Chin Piece; *B'*, Occipital Portion.

FIG. 87.—Cocking's Poroplastic Felt Jacket.

Owen, among others, employs in cervical spondylitis a stiff leather cuirass firmly encircling thorax, occiput, and chin, lined with soft leather, and fastened by straps and buckles (Fig. 86).

The value of plastic felt (according to Coking-Adams) for kyphosis was demonstrated mainly by Beely, Madelung, and P. Vogt; it is easy of application, and it can be formed into a cuirass which yields equally good fixation. The plastic felt can be applied after having been cut from a paper model. The heating necessary for moulding formerly made the application of a felt jacket somewhat difficult; but this is no longer

the case, since Bruns has taught us to saturate the felt on the body of the patient or to shape it from a model. The corset is cut from soft felt and then saturated or painted with an alcoholic shellac solution (nineteen ounces to one quart of alcohol). Two to three days are required for drying, in winter four to five, but it forms a very durable (three to six months) corset that can be easily removed and arranged for lacing.

Beely[28] has devised a very practical application of the felt jacket, which, if the necessary splints, rivets, etc., are at hand, can be readily constructed by any physician. (See Figs. 88 to 92.)

The patient is either suspended after Sayre's method, so

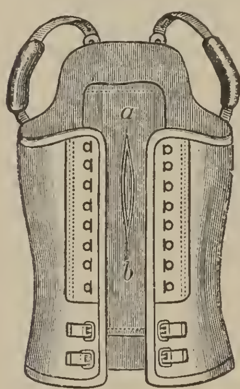


FIG. 88.

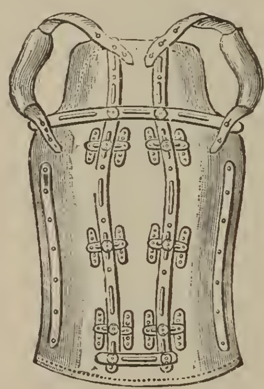


FIG. 89.

FIG. 90.

that the toes still touch the ground, or else he is seated and suspended by the head, with extended arms, and fastened by a belt transversely across the thighs (Fig. 78). Without padding, the circular plaster bandage is applied and is made just strong enough to keep its shape after it is removed. This bandage is cut open in front, removed, again closed by a plaster bandage and strengthened at the weak places. Then we may either use it as a model, or we may make a plaster cast by filling its interior. Over this plaster model we mould strong but soft felt ($\frac{1}{4}$ to $\frac{3}{8}$ of an inch thick). The margins must overlap somewhat, and where the felt does not adapt itself closely to the model elliptical pieces must be removed and the edges sewed together. The felt is next coated as far as the upper dorsal vertebræ or the mammæ with the alcoholic shellac

solution (5:7) until it is hard. In front, on each side of the mid-line, a space of from one to two inches, and above and below a space of from one-half to one inch must not be coated. Spaces for the arms and for the mammæ must be cut out, and the edges must not be coated with the shellac. After repeated coating and drying for several days, the jacket is removed from the model and is fitted to the patient in the dorsal decubitus over the ordinary undershirt.

FIG. 91 a.—Felt Jacket. (After Beely.)

On the front edges of the jacket are sewed two strips of leather, with button-holes or else two rows of strong hooks to serve for lacing, while one or two buckles with a belt (Fig. 88) are fitted below.

FIG. 91 b.—Felt Corset with Double Mast.

To the posterior surface of the dressing (Fig. 89) two somewhat elastic steel longitudinal splints are adjusted and two transverse splints firmly united by screws or rivets; the height to which they reach depends on the seat of the disease. In case of spondylitis of the cervical and upper dorsal vertebræ the two longitudinal splints are lengthened

above, brought somewhat to the side, and bent so that their upper ends project two to four inches above the vertex, slightly beyond the plane of the mastoid process, and more than the width of the head apart; these serve as jury-masts, to which are fastened by four straps a belt provided with an excavated chin-piece (Fig. 91). In this way it is possible to attain almost complete fixation of the head; and when the head is not fixed the apparatus can also be worn in the dorsal position. Carefully padded shoulder-pieces pass over the shoulders; in jackets of greater size we may further strengthen the sides by longitudinal splints, and the latter may be made to turn above the upper end of the felt jacket around a vertical axis and be rendered adjustable in any position by an apparatus similar to that in Taylor's machine. The spinal column is protected by being covered

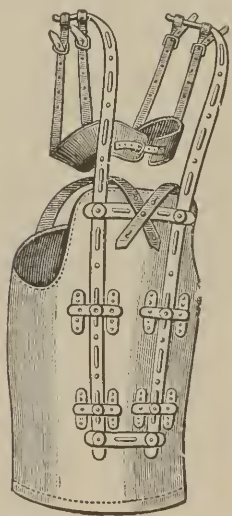


FIG. 92.—Felt Jacket (after Beely), with Double Jury-mast.

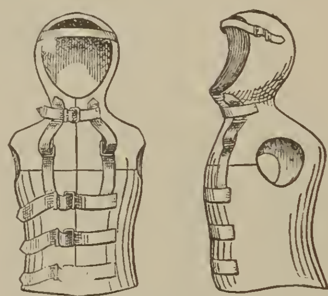


FIG. 93 —Walsham's Felt Cuirass for Cervical Kyphosis.

with a soft piece of felt (with a special incision for the gibbus) broad enough to cover the rivets.

At first the jacket should always be applied in the dorsal position and be laced below as tight as the patient can bear; above it should be loose enough to permit respiratory movements.

V. Horoch[29] states that there is a factory near Prague which makes a felt exactly like the English article at about half the price, thus rendering this mode of treatment accessible even to the poorest patients.

The felt cuirass recommended by Walsham,[30] which only

leaves the face free will always be open to objection on the score that it is too warm, even if provided with a number of openings.

Although all these jackets have the great advantage that they can be made by the physician himself and generally are not too dear, in some cases special advantages may be secured by more complicated contrivances which can only be made by a mechanic.

The majority of these consist of splints ascending along the back on both sides from a pelvic belt, or else of a firm dorsal shield (Fig. 94); many besides possess extensible axillary

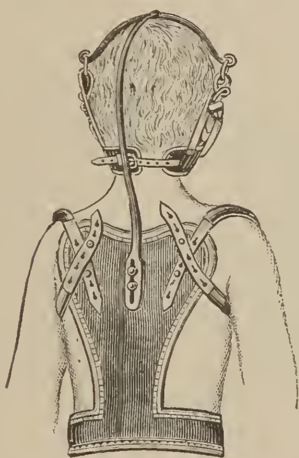


FIG. 94.—Torticollis Apparatus. (After Langenbeck-Eulenburg.)

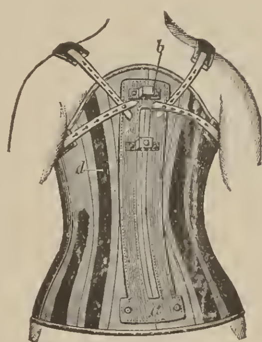


FIG. 95.—Spinal Supporting Corset. (After Nyrop.)

crutches, by means of which the collapsed trunk may be gradually raised. Especially in cases where a marked gibbus has not as yet formed may these corset-like appliances be of value, and they may be readily combined with a jury-mast for purposes of extension in high-seated spinal caries (Fig. 96). They resemble certain of the appliances recommended for torticollis.

A very useful apparatus, among others, is Nyrop's spring corset, represented in Fig. 95, in which the jury-mast, *c e*, with the head suspender, *f* (Fig. 96), may readily be inserted into the slides, *b c*, on the dorsal splints, *a*, while lateral springs, *d*, contribute to the firmness of the corset.

With reference to extension apparatus, Taylor, as has been stated, pointed out the necessity for dorsal flexion, and recommended retroflexion of the anteflexed spine against a pad placed under the site of curvature.

Taylor's apparatus [31] is one of the best known; it consists of a broad pelvic belt, from which arise two parallel steel double splints which do not touch the spinous processes and are broken by a joint at the point of the kyphosis, where they are well padded and should exert pressure. Their upper ends are fastened to the neck by two clasps and carry two axilla-

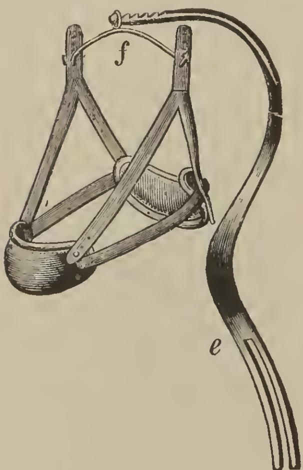


FIG. 96.—Jury-mast for Nyrop's Corset.

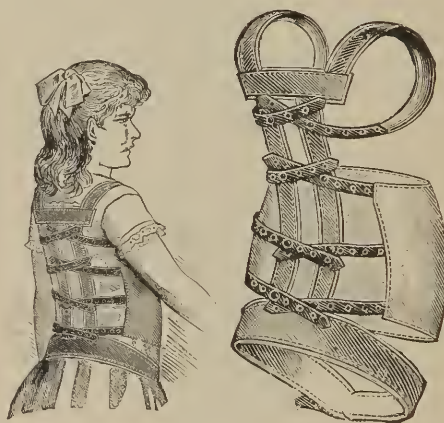


FIG. 97.

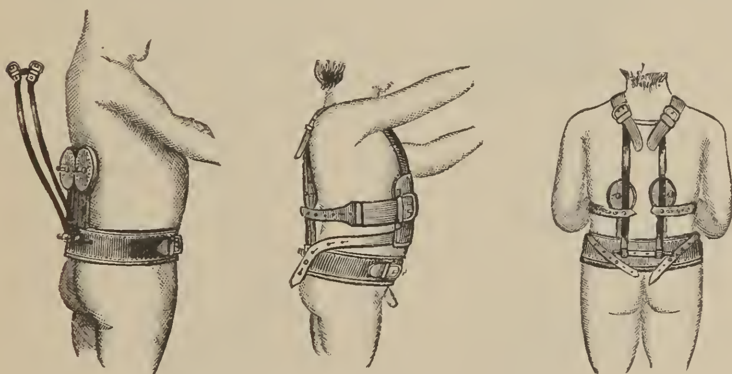
straps, which draw the shoulders backward. In case of cervical kyphosis a frame is added for the support of the head.

In order to avoid the unyielding pressure of Taylor's apparatus, Schildbach (Fig. 97) employs elastic steel dorsal splints, united above by a cross-piece. These splints are fastened to a stout pelvic belt, and carry buttons for the attachment of the axilla-straps and a broad abdominal leather belt.

In England, Chance's adaptable metal splint for caries of the dorsal and lumbar vertebræ has many adherents. It consists of two light metal splints ascending from a pelvic belt and bent according to the angle of the kyphosis. They reach to the height of the shoulders, where they are united to a plate from which the shoulder straps extend. At the angle

of the deformity, on each side of the hump, two pads are placed under the splints and exert leverage, relieving the pressure on the vertebræ, and drawing the trunk backward, while an abdominal belt prevents lordosis of the lower portion of the spine and fixes both the upper and the lower parts of the back in as straight a line as possible. This apparatus may be easily adapted to cervical caries by adding a dorsal rod and head band.

In all these apparatus for backward traction, the fatal objection lies in the fact that the deformity is increased when the patient bends forward, for which reason the material employed must be very strong. Stillman endeavored to utilize



Figs. 98 a, 98 b, and 99.—Stillman's Lever Apparatus.

for these cases a species of lever power, by joining the short arm reaching to the kyphosis to a longer frame, the two being adjustable at any desired angle.

This apparatus for ordinary dorsal kyphosis is described as follows (Figs. 98, 99):

On both sides, along the line of the spinous processes, two padded splints ascend from a belt to the seat of the kyphosis (forming the short arm of the lever). The portion of the apparatus which exerts backward traction consists of a dorsal frame (representing the long arm of the lever) fastened to the pelvic belt and adjustable at any desired angle. When both arms of the lever are set at an angle and the dorsal frame (Fig. 98*b*) is drawn close, the short arm of the lever will exert pressure on the transverse processes by means of the pads

fastened above, and then, even when the upper part of the trunk is bent forward, there is no increase of the kyphosis,

Fig. 100.

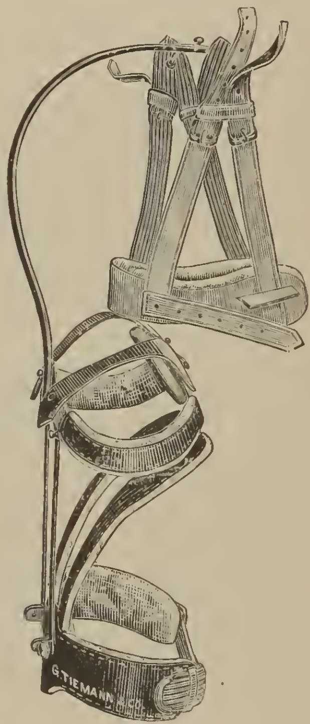


Fig. 101.

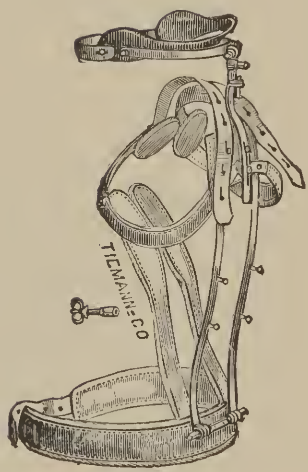


Fig. 102.

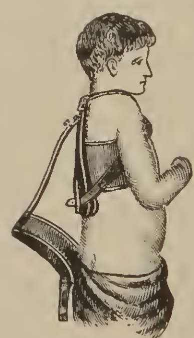


Fig. 103.

Stillman's Lever Apparatus with Jury-mast.

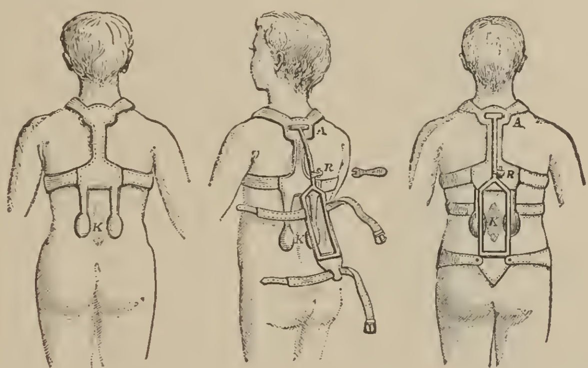
since the short arm of the lever will hinder flexion by forward pressure upon the gibbus. If well fastened, the apparatus

secures a higher grade of fixation than any other; it is light, and does not inconvenience the patient.

In apparatus for superior dorsal kyphosis the anterior straps are omitted, the long arm of the lever is fastened by axilla-straps with infra-clavicular pads (Fig. 100).

In the apparatus for kyphosis of the cervical or the first and second dorsal vertebræ a jury-mast must be added (Fig. 100), or else some other form of head-piece, by means of which the head can be fixed in any desired position (Fig. 102).

In the apparatus for caries of the lumbar (Fig. 103) or kyphosis of the lowest dorsal vertebra, the short arm of the lever would not be long enough to exert sufficient forward



FIGS.—103 a, 103 b, and 103 c.—Stillman's Apparatus for Lumbar Kyphosis.

pressure on the gibbus, *k*; Stillman, therefore, altered the apparatus to meet this objection. The base, *A*, rests at the upper thoracic region, and is fastened there by straps; from this the splints (short arm of the lever) descend to the seat of the disease, where they are supplied with appropriate pads (Fig. 103 a); while the long arm of the lever reaches to the sacrum, where it is united to the pelvic belt (Fig. 103 b). When (as in Fig. 103 c) the contrivance is fastened to the body, it represents a lever apparatus which stretches the vertebral column and fixes the spine, that is to say, it fulfils the indications. At *R* a belt is applied, which serves for the correction of any co-existing lateral deviation.

In many instances it is advisable, in order to permit a certain amount of muscular activity while the extension action is

at work, to employ special apparatus for locomotion in which the patient is partially suspended, and in this connection the various wheel crutches, etc., should be enumerated (Fig. 104). The patient may also exercise when suspended from an iron spring arm similar to that represented in Fig. 18.

For the later stages of kyphosis, when there is no further tendency to collapse of the affected portions of the spine, simple retention apparatus will suffice; for instance, corsets with accurately fitting pelvic belt and taking purchase on the iliac crests, lateral splints with axillary crutches, and slightly elastic posterior splints, with soft pads, if necessary, on both sides of the spinous processes. In still other apparatus [32] a posterior splint divides at the gibbus like a fork, and extends on each side of it. This splint is connected with the pelvic belt, and an elastic pad is placed over the prominent spinous processes, protecting them from injurious pressure and, in a measure, fixing them. Lateral splints are connected with the posterior.

Fig. 104.—Meigs' Spinal Aparatus (resembling Darrach's Wheel-crutch.)

In the acute stages of the disease, absolute rest, extension by various means (suspensory belt, etc.), and for affections of the cervical vertebræ Volkmann's extension by weights in particular are absolute indications. In the later stages, portable apparatus of varied construction, especially corsets of felt, plaster, etc., and the more complicated machines (Taylor's, Stillman's, etc.) must be resorted to, because otherwise the patients would be debarred from the important factor of exercise in the open air. Even when all symptoms seem to indicate complete recovery from the morbid process, it is advisable to have the patient wear for some time appropriate supporting apparatus, which takes pressure from the spine.

The gravitation abscesses, which are so frequently sequelæ of caries of the vertebræ, call for special consideration.

When we remember that Stromeyer declared, and with

truth for his day, that the opening of cold abscesses was not allowable because it was an operation which was nearly always followed by death or prolonged invalidism; and that nowadays, under antiseptic precautions, we not only open grave congestive abscesses, but make a wide incision, drain, etc., the change in opinion effected by the introduction of the antiseptic system is most striking. In all cases where we can guarantee efficient antiseptic after-treatment, early incision of these abscesses (as soon as they become accessible to the knife) should be the stringent rule of practice. Such is the view held by Leser,[33] of Volkmann's clinic, and by Koenig, Bardenheuer, Dollinger, and others.

Incision is followed by irrigation with warm aseptic fluid (borated salicylic-acid solution, weak sublimate solution). The pyogenic membrane is removed with the sharp curette as far as it can be detected. Usually the membrane can be easily wiped out with a wad of gauze or sponge held on a dressing forceps. Where possible, counter-incision and drainage near the diseased portion of the vertebra, suture of the wound, and antiseptic dressing should, in addition, be carefully resorted to.

At the first change of dressing, the drainage tube must be cleansed, so that permanent dressings, as a rule, are out of the question. Even where only minute fistulæ remain, strict antisepsis must be maintained.

In Volkmann's clinic, between 1873 and 1884, 58 cases of congestive abscesses were operated upon (among these 53 followed on spondylitis and the formation of a gibbus). There were no deaths from the operation; 23 permanently healed by first intention; 20 died subsequently of tuberculosis.

Psoas abscesses, which are frequently met with and can be opened even when still high in the iliac fossa, must be opened early and the purulent contents must be removed, thus guarding the patients against gravitation and spreading. This is in accordance with Dollinger's view.

The incision is made behind the anterior superior spine, and above and parallel to the crest of the ilium, and is then carried backward 2½ to 3¼ inches, the muscles being divided. The fingers are then inserted into the wound, the abscess is opened by a long incision, and the tubercular membrane is wiped out with a one to two per cent. chloride of zinc solution. After being cleansed, the counter-opening is made at the quad-

ratus lumborum and a drainage tube is inserted. Tincture of iodine diluted with water until it has merely a yellow color is also recommended for irrigation (Owen).

Retropharyngeal abscesses, in particular, must be opened early, since they may cause suffocation when they extend or rupture spontaneously. According to Hilton, deep cervical abscesses should be opened at once by incising the sterno-cleido-mastoid and making an exploratory opening through the deep fasciæ. If pus be obtained, the incision is extended. Still, even at the present time, many authorities pronounce against early operative interference (Noble Smith), and for those cases in which the necessary antisepsis cannot be assured, it should be remembered that we are also in possession of other less energetic measures, which may be carried out in dispensary practice, such as tapping the abscess with a trocar, followed by sublimate irrigation and iodoform injection. This method is performed by Schede and others.

The treatment by iodoform injections, according to the statements made by Fränkel,[34] Andrassy,[35] Verneuil,[36] and others, is a very simple, harmless, and effective procedure which is of the greatest value, especially in cases where the abscesses are very deep, if not almost or quite inaccessible. P. Bruns, for instance, had twenty permanent recoveries among twenty-two cases.

The aspirator needle, attached to the syringe, is thrust into the abscess, and the contents are withdrawn as completely as possible; then, through the same canula, we inject the iodoform solution (10 : 90 of glycerin, or 10 : 50 of water and 50 of glycerine) or a five per cent solution of iodoform in ether (Verneuil). As a rule, the amount of fluid injected should be from one to two fluid ounces, at most three fluid ounces, according to the size of the abscess.

According to Andrassy, the abscess usually rapidly refills to its former volume, and the aspiration and injection must be repeated, if necessary, at intervals of two weeks; in general, two to four injections are required. In the sixteen cases observed in the clinic until recovery was complete, the time occupied varied between two weeks and two and a half months—an average of four to five weeks (Andrassy), according to Fränkel six to eight weeks.

Skoliosis.

Under the terms skoliosis (from σκολιόω, to bend, to curve), lateral curvature of the spine (French, déviation latérale de la taille; German, seitliche Rückgratsverkrümmung; Italian, Scoliosi) we understand any permanent lateral deviation of the spinal column or a part of it from the normal physiological direction.

In a more restricted sense, the term skoliosis is applied only to the abnormal lateral curvatures caused by mechanical influences, exclusive of true morbid processes (Drachmann). The curvature seldom implicates the entire spine, total skoliosis; usually one portion of the spinal column is chiefly affected, partial skoliosis; and hence we speak of right dorsal skoliosis, left lumbar skoliosis, etc., according to the direction of the convexity of the curvature.

The curvature of a certain segment, however, never persists alone; owing to efforts at maintaining the equilibrium the original primary curvature soon becomes associated with secondary counter-curvatures (compensating curvatures); the simple skoliosis becomes compound.

Although statements such as those made by Werner (who estimated that there were 65,000 skoliotic persons in Prussia) have but a relative value, there is no doubt that skoliosis is the most frequent of all orthopedic affections. Berend found, among 3,000 orthopedic patients, 900 with skoliosis: Langgaard, among 1,000, 700; and Schilling, among 1,000, 600 with skoliosis. Drachmann, on examining 28,125 pupils, found 1.3 per cent skoliotic, 0.8 per cent boys, 0.2 per cent girls. Most observers agree that the majority of cases (9.335 per cent, Drachmann) occur in girls (10 : 1, Eulenburg; 577 : 144, Kölliker). The skoliosis of later growth (Vogt), which occurs almost exclusively among girls, is certainly traceable to definite causes, though it is possible that the proportion is rather apparent than real, and is due to the fact that the development of girls is watched with greater care and that they are, therefore, brought earlier to the physician. Even if the absolute frequency in girls is perhaps no more than double that in boys, still the physician is consulted about a much larger proportion in girls.

Roth found, among 200 cases, 183 females; Wildberger,

among 120 cases, 101; Lonsdale, among 170 cases, 149; Ketsch,[37] among 229, 189; Berend, among 896, 773, etc.

It is further of interest to note that counting the aggravated forms of skoliosis alone the number of males is in excess.

As to age, skoliosis occurs even during the first years of life, and then is usually of a rachitic nature. The great majority of cases (56.4 per cent, Eulenburg) develop between the seventh and tenth or fourteenth year, that is to say, at the time when the patients begin to go to school and are subjected to the associated injurious effects. In the female, the early establishment of puberty would seem to have an influence on the greater frequency of skoliosis.

Ketsch reports, from an analysis of the material of the New York Orthopedic Dispensary, that the number of cases of skoliosis between the first and twelfth year formed 52 per cent; from the twelfth to the eighteenth year, 14 per cent; of later development, only 3½ per cent.

Fig. 105.—Rachitic Skoliosis in a Boy of Four Years.

In general, it cannot be asserted that, aside from rachitis, an essential part is played by the diathesis in the production of skoliosis. Delicate, tall, and weakly children are most frequently attacked. In these respects, the better classes furnish the greater number of cases, while in the children of the poor bad hygienic conditions are to be blamed.

Skoliosis seems to be a consequence of civilization, and, according to several authorities, hardly ever occurs in savage races. Children with flat backs, it is claimed, furnish the greatest proportion of the graver forms of skoliosis.

As regards the tendency to skoliosis of the several portions of the spine, there is no doubt that dorsal skoliosis with the convexity of the curvature to the right (the ordinary habitual skoliosis) is the most frequent (Kölliker[38]). Drachmann states the proportion 42.3 per cent, Eulenburg 92.7 per cent, Adams 84 per cent, Heine 81 per cent. Still more recent investigatons (Drachmann, Lorenz) show that primary left-sided lumbar skoliosis is much more frequent than had been supposed; thus, Lorenz found among 163 cases, 62 left lumbar skolioses, 64 right convex dorsal skolioses; Klopsch[39] noted the same

fact, determining left convex lumbar skolioses in 71 cases out of 121 instances of skoliosis (all girls). Meyer, Schmidt, and others have made similar observations.

As will appear hereafter, however, left convex skoliosis is rare in later childhood (21 per cent, Drachmann) and more frequent only in nurslings and infants. It usually appears as a left-sided deviation (*skoliosis simplex totalis*) of a rachitic nature.

Very rarely does skoliosis consist in a simple lateral bending; as a rule the condition is associated with a rotation, a tortion (rotatory lateral curvature) rendering the deformity

Fig. 106.—Slight Habitual Skoliosis in a Girl of Thirteen Years.

Fig. 106 a.—Fixed Skoliosis in a Girl of Eighteen Years.

of the spine serpentine (see Figs. 111, 113). This compound deviation is necessarily conjoined with a displacement of the ribs and hence there results deformity of the thorax (see below) when the dorsal vertebræ are affected. We must, then, define skoliosis as a distortion of the trunk in which an abduction and rotation of the spinal column is associated with deformity of the thorax (Vogt).

According to the mode of origin we distinguish congenital, habitual, static, professional, pathological (inflammatory, cicatricial, empyematic), traumatic skolioses.

According to Eulenburg, an hereditary factor may be de-

monstrated in 25 per cent of 1000 cases of skoliosis, and P. Vogt also finds that heredity can be shown to be a cause in more than one-half of all the higher grades; in such cases there is a transmission of a peculiar form of development of the spinal column which manifests itself only at a certain period of evolution.

Congenital skolioses are, however, extremely rare, and they are due either to a *vitium primæ formationis* or they are the consequence of other deformity. Busch, among others, has described an interesting instance.[40] Rachitis and other processes associated with abnormal softness of the bones (osteomalacia) rarely of themselves give rise to skoliosis; as a rule to the abnormal quality of the bones is superadded, as a predisposing factor, the effect of weight. The most frequent form of skoliosis, the so-called habit-skoliosis, must be considered as a deformity due to the effects of weight, and here we are dealing with a lessened sustaining capacity of the spinal column occurring at the time of the second dentition and associated with the increase in growth of the skeleton which occurs at this time. These are the predisposing causes, and unequal weight on the growing parts of the skeleton is the exciting cause. So-called static skoliosis arises from unequal length or functionating power of the lower extremities, which leads to obliquity of the pelvis and to primary deviation of the lumbar vertebræ.

Staffel, for instance, found the static cause present in 76 out of 230 cases.

The pathological skolioses, on the other hand, are exceptional. Skoliosis is here due to osseous or articular disease of the vertebræ, *i.e.*, primary osteogenetic and arthrogenetic skoliosis, or to disease of the surrounding soft parts (myogenic, dermatogenic, etc.). The inflammatory skolioses are usually combined with kyphotic curvature and occur particularly in the cervical region of the spine as the so-called *caput obstipum osseum,* and also largely as arthritis deformans of the lumbar region of the spine, etc. Cicatricial skolioses may arise from extensive burns, phlegmons, defects of the ribs due to caries, necrosis, etc. Empyematic skoliosis is more frequent, and it occurs in consequence of contraction and the formation of false membranes with defective expansibility of the diseased side following on empyema; usually the concavity is turned to the affected side.

It is doubtful whether a purely muscular disease may cause skoliosis, as, for example, a rheumatic skoliosis due to inflammation of muscles (as is claimed by Eulenburg and others); cases have been recorded, however, where skoliosis has followed on a neuritic process, such as sciatica (Albert, Nicoladoni[41]). The explanation offered is that in sciatica the patient instinctively endeavors to obtain more space for the swollen nerve fibres which are inclosed in the lumbar segment of the spine, and therefore bends to the opposite side.

Only after eliminating all other possible causes may we assume that a simple disturbance of innervation is at the base of a skoliosis.

Trauma rarely results in skoliosis, since fractures of the vertebræ are more likely to cause curvature in the sagittal plane. Non-reduced luxations of the cervical vertebræ might possibly, however, lead to permanent lateral curvature of the spine.

By far the great majority of skolioses are to be considered as deformities due to weight, and since the patients permanently assume an oblique position, the vertebræ under the unequal weight acquire an asymmetrical form and thus habitual skoliosis arises. Besides the faulty position maintained during writing, which is a chief source of the deformity, a number of occupations which require an oblique position (violin playing, one-sided bearing of burdens) may cause skoliosis, and indeed we not infrequently see in some occupations what may be termed professional skolioses.

If the first tendency to skoliosis has resulted from the habitual assumption of an oblique position, then its increase toward a curvature will naturally ensue from the unequal pressure; for increase in growth of the portion of the young bone least exposed to pressure, and retarded growth of the portion most exposed, while this bone is still plastic, leads both to the wedge-shaped malformation of the vertebræ and the torsion of the skoliotic segment. If now we consider first the anatomical alterations of the skoliotic spine, by inspecting, say, a pronounced (habitual) skoliosis with right-convex dorsal, left-convex lumbar curvature, and left-convex counter-curvature in the cervical segment, it is readily apparent that the curvatures are situated, not in the sagittal plane, but in diagonal planes (Fig. 113), and even on viewing them from above

they are not seated in a frontal plane. The curvature is rather serpentine, spiral, and there is, aside from the lateral curvatures, a twisting of the median sagittal plane of the vertebræ around a vertical axis which is termed rotation or torsion and which strikes the eye on inspecting any skoliotic spine from in front, by noting the most anterior points of the several vertebræ (see Fig. 113).

A perfectly accurate conception of the anatomical alterations will be possible only when all the stages of the skoliotic process have been studied. The alterations of the initial stages would certainly be of the greatest interest. In this stage we must surmise that there has existed unequal ossification, for cases are on record where ossification had advanced

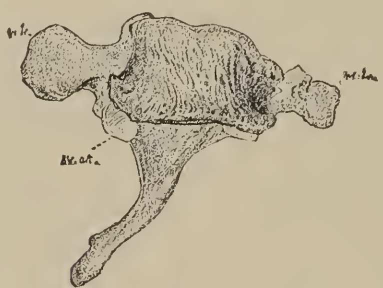


Fig. 107.—Skoliotic Dorsal Vertebra, Front View.

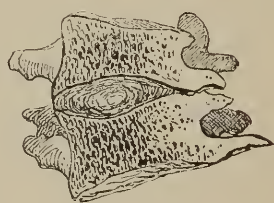


Fig. 108.—Frontal Section through two Skoliotic Vertebræ.

much farther on the convex side of the skoliotic curve (Nicoladoni).

The anatomical changes do not mainly affect the ligaments as was formerly believed, but the bony framework; and the several vertebræ not only undergo change in form by the lateral curvature, which may be briefly designated as atrophy of the concave half of the bone with resulting wedge shape of the skoliotic vertebra, but also in torsion (torsional changes) which causes the chief deformity, the costal projection.

If we compare one of the skoliotic dorsal vertebræ with a normal one, we notice, on inspection from in front (Fig. 107), that the former is wedge-shaped with the base toward the convexity (and this wedge shape is most pronounced on the eminences of the curvature and may be so great that several vertebræ are actually joined in one curve, and may become

fused into one by an osseous proliferation due to periosteal irritation). (Fig. 110.)

This wedge-shaped deformity affects not only the bodies of the vertebræ, but also the roots of the arches, the articular surfaces, etc. (Fig. 107) (Lorenz).

The root of the arch on the concave is shorter than that on the convex side; at times the former appears as if retracted into the upper surface of the body of the vertebra, often it is reduced to a very thin translucent piece of bone. The articu-

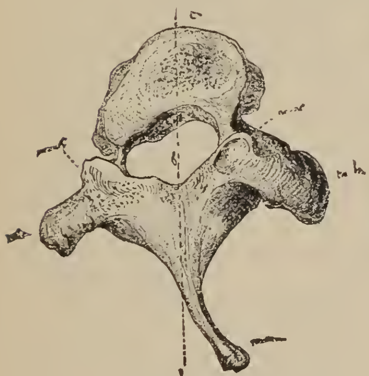


FIG. 109.—Skoliotic Dorsal Vertebra seen from in Front.

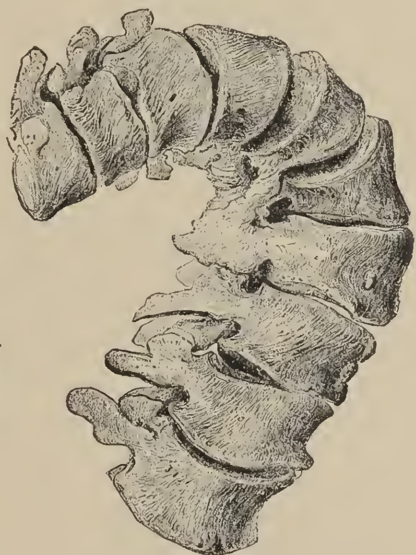


FIG. 110.—Part of the Dorsal Portion of a Skoliotic Spine.

lar surface of the arch on the concave side is also much reduced in height; the upper one in particular is often changed into a low translucent flake of bone. The articular surface, by including the neighboring portion of bone, whose periosteum is transformed into a kind of fibro-cartilage, is irregularly widened; while on the side of the convexity, where the articular surfaces are partly lifted from each other, they become gradually smaller by the disappearance of the cartilage.

The vertebral canal is ovoid, the larger end being directed to the convexity, the smaller to the concavity; this results

from the altered position of the roots of the arches which do not diverge uniformly, but have an asymmetrical direction.

FIG. 111.—Lumbar Skoliosis (rotation), Front View.

FIG. 112.—Lumbar Skoliosis (rotation), Rear View.

The root of the arch on the convex side approaches the sagittal, that on the concave side the frontal direction, and the ideal union of the roots of the arches is not sagittal in front of

FIG. 113.

FIG. 114.

the vertebræ as in the normal condition, but on the side of the convexity. The vertebral body itself is even asymmetrical, the concave half presenting a more frontal, the convex half a

more sagittal direction. On viewing a macerated skoliotic spine from in front, we observe a peculiar oblique direction of the bony fibres instead of a vertical one; this is especially noticeable in the single vertebra (Dittel, Fischer, and others), and becomes more conspicuous the higher the grade of the deformity. The internal vertebral structure is also similarly altered, the oblique course of the bony trabeculæ producing a shortening of the vertebra; hence the torsional changes should be looked upon mainly as a torsion of the bones (Volkmann, Lorenz) and not as a rotation in the articulations.

Similarly, the transverse process of the convex side has

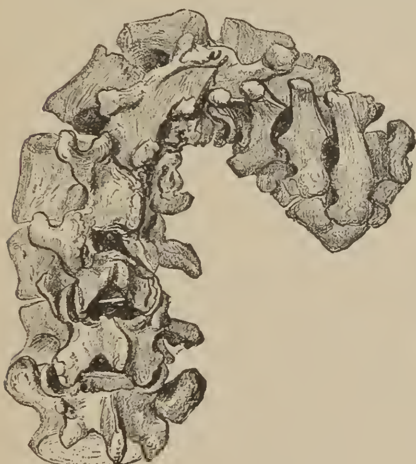


Fig. 115.—Portion of a Skoliotic Spine Seen from Behind.

Fig. 116.—Skoliotic Spine and Protruding Ribs, Rear View (Specimen in the Munich Pathological Institute).

usually a more sagittal position and is directed more backward; that of the concave side is more frontal and the angle formed by the transverse and spinous processes becomes more acute on the convex side, the *sulcus paraspinosus* being narrower, etc. (Fig. 117).

The spinous processes are displaced to the concave side with reference to their insertion, whilst the direction of the points of the dorsal spinous processes form, so to speak, an excrescence toward the convexity. The row of the extremities of the spinous processes does not correspond with the intensity of the curvature, being sometimes in a straight line (Fig. 112) notwithstanding aggravated skoliosis.

As regards the explanation of the appearances of torsion, it is no longer possible to accept the view of Nicoladoni (who looked upon them as an optical effect) or that of Hencke, viz., rotation in the articulations. The same may be said of the different attempts at explanation by Roser, Meyer, Maigaigne, Dick, Eulenburg, Drachmann, Schenck, etc., which will be found in Lorenz's work. Lorenz finds in the presence of the epiphyses of the roots of the arches the tendency to torsion of the growing vertebra, in the same way as the epiphyses of the bodies of the vertebræ favor the wedge-shaped deformity, and he lays stress on the sudden bend of the basal epiphyseal joint of the roots of the arches toward the middle line or the concave side; for here, as the point of least resistance, the root of

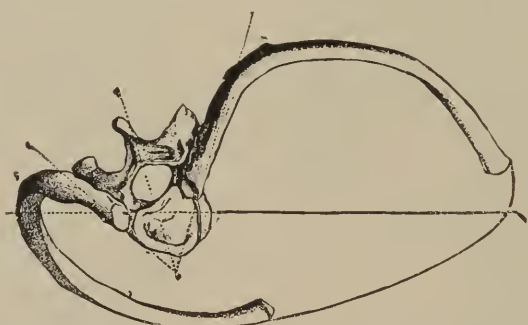


FIG. 117.—Skoliotic Thoracic Hoop. (After Lorenz.)

the arch with the adjoining thoracic hoop, as it were, remains behind the body of the vertebra which is crowded out of the middle line as the result of pressure.

Of the greatest importance with reference to the deformity are the anatomical alterations of the ribs which are closely united with the vertebræ and which cause the marked change in the shape of the thorax. These alterations may also be divided into alterations in position and into alterations of torsion (changes in shape), the latter being much more important. Since the rib, as far as its angle, is to a certain extent dependent on the arch of the vertebra, there results a more or less sagittal direction of the root of the rib on the side of the convexity; hence the greatly flexed costal angles cause a serious deformity, (the so-called posterior costal eminences), while the ribs of the concave side, being directed more to the front,

show a diminished curvature and this explains the flattened condition of the skoliotic thorax.

These costal curvatures at the posterior part must correspond to diametrically opposite curvatures at the anterior part of the ribs, and the places where the more strongly curved portions of the ribs join the more extended portions are termed, in turn, the anterior costal eminences (at *k*, Fig. 117). As to the changes in position of the ribs in skoliotics, in case of dorsal skoliosis all the ribs are depressed on the side of the convexity (Fig. 116)—a fact to be explained probably by the resistance of the muscles of the trunk to their elevation (Lorenz). At the concave side, the ribs of the lower border of the curvature are moderately depressed; superiorly this depression becomes less, the ribs grow horizontal and finally are slightly elevated. The ribs of the convexity are divergent, while those on the concave side are approximated, usually atrophic, and where the skoliosis is great they may articulate with each other or be united by synostoses.

In skoliotics, therefore, the thorax is oblique, and in right-convex curvature the thorax extends in the right, in left-convex curvature in the left diagonal diameter; the convex half of the thorax is diminished in all dimensions, the capacity of the concave side is lessened only in height, but is increased in all the other diameters. In a horizontal section the skoliotic thorax represents an ellipsoid whose greater axis is formed, in right-convex curvature, by the right, the lesser by the left diagonal diameter (Fig. 117).

Aside from the rachitic form, the pelvis in case of habitual skoliosis is not in general much deformed. Adams says in this connection: "Obliquity of the pelvis is supposed to exist much more frequently in cases of lateral curvature than it really does." In the severer degrees of skoliosis, especially that of the lumbar segment, the pelvis is somewhat oblique. The deformity of the sacrum is above all the cause of asymmetry of the pelvis. In left-convex lumbar and in right-convex dorsal skoliosis the left diagonal diameter of the pelvic inlet appears elongated, and the right shortened; hence the obliquity of the pelvis is opposed to that of the thorax.

The changes in the ligaments are only the consequences of the alteration in the shape of the affected parts of the skeleton, and those of the muscles (especially of the long dorsal

muscles) are not very marked. In the early stages of the skoliosis there are no changes in the muscles; in more chronic cases, the muscles on the side of the convexity are relaxed, pale, and fatty degenerated, while those on the concave side are altered to a less degree. The relations of the long dorsal muscles to the spinous processes are altered, the distance between them being increased on the concave side, and lessened on the opposite side; in the higher grades of skoliosis the longitudinal muscles may become subluxated over the spinous processes on the concave side. The broad dorsal muscles also adapt themselves to the deformity of the thorax; thus the rhomboids, passing over a costal eminence on the convex side, are usually thinned and atrophic; on the concave side they are shortened and thickened.

The numerous theories in regard to skoliosis can scarcely be harmonized with these anatomical findings, and we shall here consider only very briefly the various attempts at explanation. As Copeland aptly says these views furnish material for a keen satire on the medical art.

Up to the beginning of the present century, skoliosis was looked upon as an arthrogenous affection, and the ligaments in particular were thought to be at fault. Delpech, Guérin, Eulenburg, and others sought the causal factor in disturbed muscular antagonism (the myogenous view). Some assumed a paralysis of the dorsal muscles on the convex side, others a contraction on the concave side of the curvature, and the latter view led to the performance of myomotomies in skoliosis, which operation was shown by Malgaigne to be based on false premises. A weak constitution was considered to be the predisposing cause of the habitual oblique position. This led to passive dilatation and weakening of the dorsal extensors on the convex side, the exciting cause of skoliosis. Although this myogenous theory has been sufficiently refuted by Werner, it is still held by some. Neither the anatomical nor the clinical facts are supported by Stromeyer's respiratory theory which explains the skoliosis by a unilateral relatively stronger action of the right serratus—a view maintained by Sayre, for instance, for primary dorsal skoliosis. The views maintained by Malgaigne and Adams of a primary relaxation of the ligamentary apparatus, or Werner's gratuitous view of the primary disturbance of the will, also offer insufficient explanation. A

mere historical interest attaches to Hueter's theory of pressure by growth of the ribs, the fallacy of which was clearly shown by Dornblüh and Lorenz, and is proved, in addition, by the occurrence of primary deviations in other segments of the spine.

Lorinser defended mainly the osteogenous explanation, *i.e.*, he found the tendency to a skoliosis in an insidious inflammation of the bone, an inflammatory softening process, the patient instinctively assuming the position in which he escaped as much as possible the effect of pressure on the softened part. Lorinser sees in skoliosis a morbid process in nowise differing from kyphosis, but considers both expressions of the same disease, only varying in degree. The cases, however, are rare in which we find anatomical alterations corresponding to this theory (as in a case recently observed by me).

Von Lesser [42] produced skoliotic curvature experimentally in animals by unilateral division of the phrenic nerve and believed that unequal functional development of the two halves of the diaphragm also played a part in human skoliosis.

Another theory sees in skoliosis only a pathological increase of the lateral curvature which, according to Sabbatier, Bouvier, and others, is physiological. It is not certain, however (Adams, Lorenz), that skoliosis is physiological as is claimed, about the seventh year, and which is thought to be due to the pulsations of the aorta (Sabbatier), to the greater weight of the organs on the right side (Desruelles, Struthers), to habitual right-handedness (Busch), and generally to an increased growth of the right side of the body. Schildbach and others defended the view of a primary anomaly of growth. The theory of pressure, which is applicable to the majority of skolioses (Roser, Volkmann, etc.), *i.e.*, the conception of skoliosis as a gradual transformation of the previously well-formed spine under mechanical influences has at present the greatest number of adherents.

It is evident that in most occupations and even in ordinary relaxed attitudes, unequal pressure is present, and that, if this be continous, especially about the seventh year at the time of the second dentition, which is associated with increased growth of bone, development will be uneven and the deformity will become greater. Attendance at school at this critical time, and especially faulty position during writing, which is largely

due to badly constructed seats, are chiefly to blame for beginning skoliosis.

In the position which the fatigued child usually assumes in writing, the right shoulder is higher and projects forward, the right forearm rests on the table, while only the left hand or a few fingers, touch the oblique book or the table,[43] especially when the desk top is too far from the seat; this causes a right convex dorsal curvature of the spine. According to others, the left curvature of the spine (Fig. 118), especially that in the lumbar region, is more frequent, but its frequency is underestimated owing to the symptoms being less conspicuous. Schenck has determined with a special apparatus the position in writing of 200 children, and found that in 160 the trunk was displaced to the left on the pelvis, the weight of the body resting on the left elbow and arm, thus producing a left-convex total skoliosis; 34 pupils displaced the trunk to the right, but turned to the left so as to relieve the pressure on the right forearm which was used in writing, and they exhibited an habitual dorsal skoliosis with very pronounced right dorsal flexion; only 6 showed no lateral displacement of the trunk during writing; in all, excepting 38, the pelvis was not parallel but oblique to the edge of the desk.

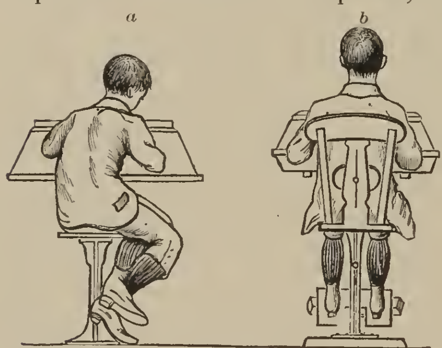


FIG. 118.—*a*, Faulty; *b*, Correct position. (After Roth.)

In addition to faulty position in writing, skoliosis is favored by all acts and occupations causing obliquity of the pelvis and sinistro-flexion of the trunk. Here unequal pressure and the resulting dissimilarity in growth cause skoliosis.

As for the symptoms of skoliosis, the onset cannot be determined clinically. The affection must reach a certain degree of development before it gives any external indications. Rarely it is the curvature in the line of the spinous processes which is first observed, more frequently the greater height of one shoulder or hip; often, in beginning skoliosis, it is possible to recognize only a slight displacement of the trunk on the pelvis, which is always in the direction of the primary curva-

ture (in the right primary dorsal curvature to the right). As a result of this displacement, the lateral borders of the body become asymmetrical; in right displacement the right waist line and the right crest of the hip disappear, while the left outline has a concave sweep, the left hip being prominent, the left waist line somewhat deepened, and *vice versa*. The arm, on the side of the displacement, hangs down; on the opposite side it is opposed to the crest of the ilium, where it forms a triangle with the waist line (Lorenz) which becomes unequal in bilateral skoliosis (see Fig. 120). According as there exists a primary lateral curvature in the lumbar or dorsal spine, we find the position of the hip or shoulder altered as the expression of the deviation of the vertebral column, and according

FIG. 119.—Beginning Skoliosis (right side), Girl aged Four.

FIG. 120.—Primary Left convex Lumbar Skoliosis. (After Lorenz.)

to the appearances we may distinguish between a primary lumbar and a primary dorsal skoliosis.

In primary left-convex lumbar skoliosis, the relatively frequent occurrence of which, as a primary deviation, has been repeatedly referred to, the left angle of the waist appears flattened or completely obliterated in the higher degrees, so that the left arm is in contact with the lateral surface of the trunk nearly throughout. The right angle of the waist, on the contrary, is more acute, and, in well-nourished persons, a transverse fold extends toward the middle line, while the distance of the arm from the waist line is increased. There results, hence, a diminution or disappearance of the left, an increase in the right triangular outline of the waist, that is to say, a deepening of the right waist line. The left waist line, and the

crest of the left hip disappear; on the side of the concavity they become more prominent, and, owing to the rotation of the lumbar spine, the left lumbar region becomes fuller. A prominence is visible in the left lumbar region along the middle line which is also noticeable on palpation and especially when the patient bends forward. The longitudinal swelling of the erector trunci appears much flatter than on the right, because the transverse processes deviate forward. As the affection increases, changes of position (counter-curvatures) also occur in the dorsal vertebræ. Primary right-convex lumbar skoliosis, a very exceptional condition, causes similar changes, although, of course, on the opposite side.

Primary right-convex dorsal skoliosis (next to the left-convex lumbar skoliosis the most frequent and important variety), in its first stages, while the spinous processes may still be entirely in the middle line, presents a slightly increased curvature of the right costal angle which becomes more conspicuous on inspection from above. Soon the changes in the position of the scapulæ become marked, *i.e.*, the right scapula projects backward, is somewhat higher, and its outlines are sharper (resting as it does on a higher base, that is, on the more strongly backward-curved ribs); while the less prominent left scapula, slightly twisted, approaches with its angle the sagittal axis (the left upper extremity sinking down on the flat ribs), and a fold of the skin extends from the left scapular angle down and outward to the waist line. Essential alteration of the lateral contours is not perceptible. Shortly, the secondary lumbar curvature is superadded and at the same time the lateral outlines become more and more asymmetrical, the right waist line becomes deepened, the right hip more prominent, while the crest of the left hip is obliterated, the left triangle of the waist is elongated and nearly semilunar. This latter circumstance presents an essential differential point from primary left convex lumbar curvature (Lorenz). The concavity of outline on the left side becomes

Fig. 121. — Primary Right-convex Dorsal Skoliosis. (After Lorenz.)

still more pronounced when the entire trunk is displaced on the pelvis to the right. Then the angle on the right at the waist opens outward, the right arm hangs down straight and the projection of the right hip is absent (Fig. 122).

As soon as we can recognize a deviation of the spinous processes, the diameter of the half of the body on the side of the convexity appears shorter, and this is also the case in lumbar skoliosis, while in dorsal curvature the conditions are obscured because the greater distance of the right scapula from the spinous processes simulates a widening of the right half of the trunk.

In case a compensatory left-convex cervical curvature is superadded, then we notice a characteristic alteration in the shoulder line across the neck. This normally forms a gentle double curvature. It becomes flattened on the left, the left side of the neck is shorter, and the rounding of the left shoulder is less prominent laterally; while on the right side the neck is longer, the rounding of the shoulder more prominent, and the line across the shoulders is more curved.

In comparison with this form of curvature of the fully developed habitual skoliosis (*skoliosis duplex adolescentium*), the remaining forms are of but little practical interest on account of their rarity, and their symptoms will be discussed in connection with rachitic and static skoliosis.

The onset of skoliosis differs in so far as in certain instances left-convex lumbar skoliosis appears first, in others right-convex dorsal skoliosis. Only exceptionally does the deformity begin at the outset with several curvatures.

Ordinary habitual skoliosis, as a rule, has an insidious course, it develops slowly and increases gradually; but at times, especially in girls of rapid growth, the development and increase of the affection are exceedingly short, so that in the course of a few months high grades of deformity may be produced; usually the affection progresses the more quickly the younger the patient.

In general, three stages may be distinguished:

In skoliosis of the first degree we deal, as it were, with an habitual skoliotic attitude; marked costal projection is not yet present; by vertical suspension, horizontal decubitus, or slight manual pressure the curvature of the spine can be readily made to disappear.

In skoliosis of the second degree the deformity can no longer be entirely removed by active motions, suspension, etc.; the torsional changes are marked, and the differences in level of the posterior surface of the thorax disappear only in part even on suspension, although the curvature of the spine may still become quite or nearly obliterated. As a rule, compensatory counter-curvatures have already developed.

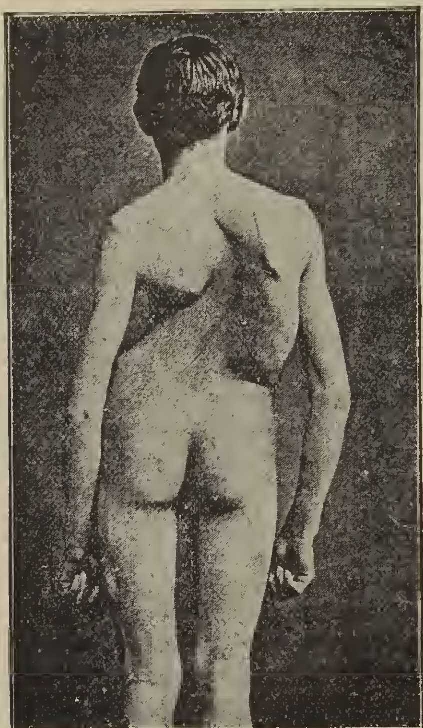


FIG. 122.—Pronounced Grave Habitual Skoliosis.

In skoliosis of the third degree, there is complete or almost total unalterability of the curvature, whether on manual efforts or on vertical suspension. The spine has become rigid by unilateral atrophy and ankylosis.

Skoliosis may become stationary in any stage and does not always reach the highest grades.

Early diagnosis of commencing skoliosis is of the greatest importance, since the first stages chiefly offer hope of cure from treatment. The indifference with which the anxious mother is quieted by the physician consulted for the "high shoulder" or the "oblique attitude" of a child, with the statement that this will be "outgrown" and spontaneously disappear, without even making a careful examination, cannot be too strongly condemned and must be taken to indicate a lack of conscientiousness when we bear in mind how frequently skoliosis and its consequences destroy the happiness of the afflicted individual.

Eulenburg justly criticises the indifference of many family physicians toward beginning skoliosis, "for while in other diseases not pertaining to their special sphere, as of the eye,

ear, etc., they usually refer their patients to a specialist, in cases of spinal curvature they unnecessarily assume a responsibility which the daily sight of numerous unfortunate victims should have rendered distasteful to them."

The factors to be taken into consideration, therefore, in the examination of a beginning skoliosis must here be discussed more in detail. By inspection we must first notice the attitude of the patient (whether there is displacement of the trunk on the pelvis, whether one shoulder is higher than the other, whether the waist is oblique, etc.); in addition, we must observe the excursions of the thorax during respiration. The fact must be emphasized that the patient must be stripped down to the trochanters. The clothing should be tied around the trochanters, otherwise the patient, in order to prevent their fall, moves constantly and does not remain quiet and erect. The hair should be tied over the head, the arms should hang free at the sides, the toes should be equally directed outward. After the patient has been inspected in his ordinary position he is told to assume a firm military attitude. Under good illumination, the light by preference falling from behind on the patient so that no disturbing shadows are thrown, the back is inspected from behind and from varying distances, the relations between pelvis and trunk, the position of the shoulders, the lateral outlines, the waist lines, the relations of the pendent arms to the trunk, the condition of the triangle of the waist, etc., being noted. On inspection from in front, the relations of the neck, navel and symphysis should be noted, as to whether they are in one plane, whether one region of the costal cartilages projects more strongly or one mamma is more prominent, whether the sternum is in the middle line, etc. The spinous processes are next stroked by the finger tips, a red line being produced marking the course of these processes and making a curvature or deviation from the normal evident; the condition of the paraspinal sulcus is noted, as to whether it is filled up on one or the other side, etc., and in high grades of torsion care must be had not to mistake the lateral vertebral processes, which are well marked on the convex side, for the spinous processes.

In beginning dorsal skoliosis it is advisable to cause the patient to lay his hands on the opposite shoulders, crossing the arms, or else the patient with extended knee joints and

raised arms should be directed to bend forward, whereby the region of the costal angles can be better inspected and the fact of torsion becomes more evident.

The possibility of overcoming any alteration of form is next tested by attempting to restore to its normal position the projecting costal eminence by means of gradual pressure. Next it is noticed whether static alterations (*e.g.*, the placing of a book under a shortened leg, etc.) will cause disappearance of an existing curvature. The condition of the patient having been tested both under active changes of position and by passive measures (diagonal manual pressure), if the curved segment is found to be even slightly movable, the behavior during vertical suspension is tested to determine whether compensation can be effected or not, and at the same time we may endeavor by means of manual pressure to ascertain if the thorax can be sprung back into the normal position, as is usually the case in children with slender bony framework.

Sometimes it is essential to examine also in the horizontal abdominal position. The length of the legs must always be carefully compared.

The prognosis of skoliosis in general is unfavorable, and only when the case comes early under treatment may a good result be attained and the progress of the disease be arrested. The prognosis in primary lumbar skoliosis is, in particular, more favorable. Correction of the deformity here presents less difficulties. By means of Lorenz's belt dressing (see below) with elevation of the corresponding half of the pelvis by the interposition of extra soles on the shoe, cure may be effected in a relatively short time, that is to say, in a few months. The prognosis of primary dorsal skoliosis is worse, but in general more favorable when the changes in shape of the ribs are not pronounced. Where the disease begins without notable lateral displacement of the thorax, it is usually first noticed through the projection of one shoulder, and in most cases we must rest content with preventing the further advance of the curvature. We must beware of assuming too early that the skoliosis has become stationary, and we must rather consider it the rule that a beginning deviation progresses into the higher grades. The third stage is absolutely incurable.

Skoliosis is a permanent misfortune, not alone on account

of the deformity, but also because of the associated embarrassment of the respiratory and circulatory organs. For although the general health, even if the patient is skoliotic in a high degree, is often very little affected and the thoracic organs adapt themselves nicely to the altered space, still, in the graver cases, there is a certain insufficiency of respiration, there is dyspnœa on moderately active movements, which becomes quite marked on prolonged muscular exertion during walking, singing, etc. There is also a tendency to chronic catarrhs, etc. Digestive disturbances, congestions, cyanosis in consequence of defective emptying of the cardiac cavities, a certain tendency to hemorrhages, etc., these should be considered as direct sequelæ of grave skoliosis. According to Bouvier, heart lesions and apoplexy are the most frequent causes of death in skoliotics.

Severe skoliosis may further be accompanied by very painful symptoms. Aggravated neuralgia may be caused by pressure through the depressed ribs on the intercostal nerves.

Positive proofs are wanting in regard to the truth of the belief that skoliotics are short lived. The risks from skoliotic pelvic anomalies in women have also been greatly overestimated; only when the disease is of high grade, especially if of rachitic origin, does it interfere with gestation. This is certainly not the case in the slighter grades of the deformity.

In order to enable us to observe the course of the affection and the influence of treatment, we must resort to scientific methods of measurement in skoliosis. Since the taking of plaster casts at intervals for obtaining a picture of the deformity (Heine) is rather cumbersome, and the outlining of the trunk by means of the camera obscura (Schildbach) reproduces only a small portion of the alterations, it was but natural that the photographic reproduction of the patients, as practised by Berend and Wildberger, should find many imitators, particularly since stereoscopic views yield such excellent reproductions of the curvature that they were specially recommended by Lorenz.

In order to obtain actual measurements of the skoliotic curvature, it was formerly the custom to notice mainly the lateral deviation from the vertical; to take the diameter with the callipers or the outlines with a lead band or kyrtometer so as to gain by this means, at definite intervals, a picture of the progress of the affection, etc.

Only in recent times, however, have we had at our disposal exact scientific apparatus which will soon displace the methods of earlier date.

Bühring's [44] apparatus consists essentially of a glass plate 16 inches broad and 20 inches high, divided into half-inch squares, which is movable by means of a frame on a vertical scaffold on the sides of which is a device for fastening the arms. In the centre of the upper border of the frame is a plumb line, while below is a horizontal projection to which is fastened a diopter movable on a vertical rod. The apparatus with the diopter is placed toward the light with the patient behind it; his arms are fastened to the scaffold, and the outlines are drawn on the glass with a brush and paint; the plumb line is fastened at the level of the spinous process of the seventh cervical vertebra, and by means of the diopter the curvature of the spine and its deviation can be accurately marked. The apparatus, therefore, permits only the measurement or pictorial representation of the line of the spinous processes and of the lateral contours; it gives no picture of the torsion and no real image of the deviation of the vertebræ, and is hence of little practical interest for the measurement of skoliosis. The same may be said of Gramko's method.[45]

The apparatus which permits measurement in two or more planes is more suitable, for instance, that of Heather Bigg.

Schildbach's camera gives only the outlines and cannot reproduce the differences in level of the back.

For obtaining horizontal contours, a good apparatus is the thoracograph made on the system of the hatter's form by Walter Biondetti at the suggestion of Socin. About four to six thoracic outlines are drawn and designated by the corresponding spinous processes; these are cut out of strong paper for comparison with those taken later.

The apparatus of Murray [46] (Stockholm) is similar to Burkart's modification of the above.

The thoracograph of Schenk [47] permits the drawing of the horizontal outlines and of measurement at any desired point; the patient is placed in the centre of a massive ring, the pelvis and shoulders being fixed and the head resting against a pad. Around the ring is the plane for drawing; where this plane joins the ring is a vertical column divided into centimetres which bears the movable bent index pointing inward and

connected with the writing lever lying on the movable plate. While the drawing-plane is carried around the ring, the index, depressed by a rubber band, follows the outlines of the body horizontally and the writing lever marks on the slowly rotating writing plane the exact tracing of the motions of the index. It is possible by means of this apparatus to project any point of the body on the horizontal plane. Schenk usually makes one outline at the height of the spines, another at that of the acromia, measures the line of the spinous processes every five centimetres and projects the position of the several points on the drawing-plane, so that at the termination of the measurement the line of the spinous processes may be constructed in a sagittal and in a frontal direction.

For simple measurement of the lateral deviation Heineke's pendulum rod [48] is appropriate. After marking the spinous processes with a blue pencil, the belt with the triangular plate is laced around the pelvis, so that the point of the metal plate is exactly over the anus. Opposite to this, on the metal plate, a rubber cord is fastened and is stretched to the spinous process of the seventh cervical vertebra and thus the points where the sagittal plane and the line of spinous processes cross can be easily marked, and the deviations from the sagittal plane may be measured in centimetres. For measuring any lateral inclination of the spine as a whole, the pendulum rod is used, being hung to a stud projecting at a right angle from the belt plate. As the rod is divided into centimetres and reaches to the head, any deviation from the median line, for instance of the vertebra prominens, can be readily measured.

The skoliosometer of Mikulicz [49] permits the measurement of the height of the spinal column, its lateral deviation, torsion, the height and position of the shoulders. It consists essentially of a vertical and a horizontal narrow steel band, flexible so as to follow the lines of the body, and divided into millimetres. These bands are so joined by a brass piece that the horizontal rod can be moved both laterally and vertically. The longitudinal rod is fastened to a metal plate (which is joined to a pelvic belt by a corresponding pad) and it carries a horizontal goniometer from which may be read the position of the thin pointer which forms the end of the longitudinal band, the motion of which is around a vertical axis (indicating the torsion).

Since the apparatus is movable around a horizontal axis at the pad, the longitudinal rod can always be given the direction of the inclined spine. Height, lateral deviation, and position of the shoulder blades are measured by corresponding position of the transverse on the longitudinal rod. According to Mikulicz, measurements with this simple apparatus can be completed in from five to ten minutes.

Probably the most complete apparatus for measuring skoliosis, the only objection to which is its high price, and the application of which is simple and rapid (fifteen to twenty minutes for complete measurement) is that of Schulthess.[50] It permits measurement in three planes and gives a complete plastic representation of the trunk, and all the important bony points can be fixed in their mutual relations. It consists of a heavy cast-iron frame, the sides of which are joined at the back and bottom by iron rods, and which carries the devices for fixing the patient and making measurements or drawings. For fixation there are four adjustable pads: two to rest against the anterior superior spines (2 and 3), two broader ones for the hip or pelvis (4 and 5), which can be set parallel to the measuring plane. A board, 1, which can be set higher or lower on the four toothed rods of the side-pieces, permits the use of the apparatus for persons of different heights.

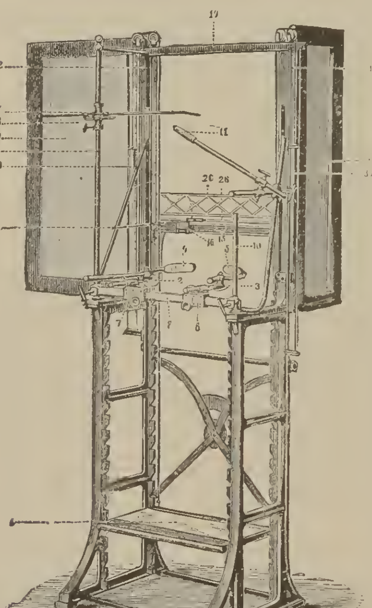


FIG. 123.—Schulthess' Apparatus for Measuring and Delineating Spinal Curvature.

The base of the measuring and drawing appliance is formed by two exactly parallel lateral slides, 12, 13, and their transverse connection, 14; between the former is a brass frame, 15, about twenty inches broad, which can be moved up and down,

being held in equilibrium by a counter-weight running over pulleys, so that a slight pressure of the hand suffices to raise or to lower it. On this frame, 15, is a small rider which travels to and fro, and in order to permit motion also in the third dimension (depth), the rider is perforated at a right angle to the direction of its motion, the perforation carrying a blunted steel pointer, 17, which can be greatly lengthened by the addition of a second pointer. Hence this pointer can follow the course of any line accessible to the measuring frame. The motions of the pointer are transmitted to the paper-covered glass plates, which are at right angles to each other, in the following manner:

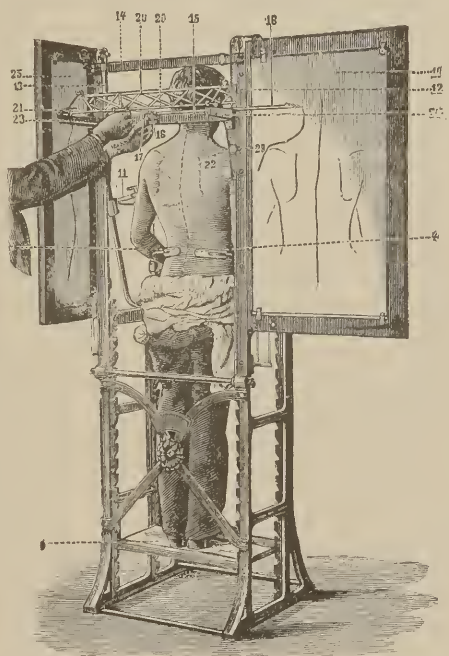


Fig. 124.—The Same Apparatus in Use; on the Right Plate is the Projected Frontal Picture; on the Left, the Posterior Sagittal Contour.

1. From the rider, 16, a horizontal lever twenty inches long is extended laterally, 18, and it carries at its outer end a pencil which marks on the vertical plate, 19. This plate has the same direction as the measuring frame and forms the projection of the object to be measured on the measuring plane (Fig. 124).

2. The posterior end of the pointer, 17, is so joined to a steel rod, 20, placed parallel to the brass frame by means of a forked eye, that it may be easily shifted from one end of the rod to the other. The steel rod with its two ends lies, by means of two rollers, 21 and 22, on the rail-like carriers which project backward from the brass frame, 23, 24, and it thus follows the slightest motions of the pointer connected with it, while it remains at rest during lateral movements of the rider, 16, or pointer, 17. To assure these movements, especially with ref-

erence to the parallelism of rod and measuring plane, its outer ends are united at the rollers by means of two levers to a right-angled lattice, 26, which in turn is made movable in the rails, 23, 24, by dowels at its two lower corners. At one end of the steel rod, 20, is a pencil which writes on the smaller vertical plate, 25, and furnishes the tracings of the kyphotic or lordotic deviation, and these tracings may be taken at any point of the back.

3. For delineating horizontal contours, there is applied to the posterior end of the pointer at a right angle to it, a writing lever, and when this is to be used, the brass frame is fastened with a screw, a paper-covered glass plate is inserted horizontally between the rails, 23, 24, and the pointer is made to follow the contours from right to left, or *vice versa*, whereby half-outlines can be obtained at any level.

This measuring device is completed by an index, 27, marked in centimetres, which is movable, with the sheath in which it rests and the graduated curve, on a vertical rod smooth on the back and marked in front in centimetres, 9; the index can be both rotated and drawn in and out of its sheath (in order to determine the position of certain points on the anterior surface of the body). (See Fig. 123.)

By reading off the dimensions: 1, the length to which the rod has been drawn out; 2, the height at which it stands; 3, the angle around which it has been turned, we can always reproduce the position after the patient has left the stand and transfer the various points to the writing planes by means of the pointer, 17.

Thus any line within reach of the pointer can not only be followed, but may be reproduced on the three plates, and all the drawings thus obtained are projections.

For taking the measurements, the patient, after the line of spinous processes and the scapulæ have been marked, is placed on the board, 1 (which may be covered with paper in order to draw the outlines of the feet), then the toothed rod is inserted, the pads, 2 and 3, are placed against the spines, the pelvis-holders are pressed close, the iron rod is laid against the upper end of the sternum, and the pointer is carried along the line of the spinous processes, when the two writing levers mark on the vertical plates, 19 and 25, giving the skoliotic and kypho-lordotic curvature. Then the outlines of the scapulæ are drawn

and two vertical profiles over the two scapulæ, also the outlines of the figure against the light, and at last some of the horizontal contours, and their extent are measured by one or both levers on the vertical plate. Then the patient steps out of the apparatus and the points measured on the anterior surface of the trunk (projection of the sternum) are drawn. After drawing a vertical line on the sagittal and frontal outlines, and a line parallel to the measuring frame on the horizontal outline, the measurement is finished.

In addition to the ordinary habitual skoliosis, we must take into account the rachitic and static forms. Rachitic skoliosis (which according to Guérin occurs in about 9.7% of children affected with rachitic curvatures) originates from overburdening (unequal effect of pressure) of the rickety (pliable) bone; it usually occurs in the form of an arched (dorso-lumbar) curvature.

The oblique posture when carried on the arm of the nurse, etc., has been mainly considered as the cause of this deformity, and the greater frequency of left-sided skoliosis has been explained on the same theory.

The fact is that in rachitic skoliosis left-sided curvature is much more frequent (9 : 5 Eulenburg, 3 : 2 Heine), the deformity being arch shaped, with the greatest deviation about the middle of the spine.

According to most observers, the two sexes are about equally affected, although some have found boys in the majority. With reference to age, the second year yields the greatest number of cases, that is to say, rachitic curvature begins almost constantly in the first years of life, at the latest up to the fifth year, and the frequency toward the sixth year decreases rapidly (Eulenburg).

As regards the symptoms of rachitic skoliosis, aside from other rachitic manifestations, the predominance on the left side and the arched shape of the curvature should be noted. The vertex of the arch is nearly in the centre of the entire spinal column. The counter-curvatures are high up in the dorso-cervical and below in the lumbo-sacral portion of the spine; the greatest projection of the primary costal eminence lies below the shoulder blade, and hence the differences in level of the scapulæ are less obvious, while a marked prominence of the shoulder in the region of the dorso-cervical counter-curva-

ture is more frequent (Fig. 125). As a rule, in pronounced rachitic skoliosis the costal eminence lies below the left shoulder-blade; in (left-convex) curvature of the median portion of the spine there is moderate (left) displacement of the trunk upon the pelvis, the (left) arm on the convex side hanging free.

In rachitic skoliosis, changes in the pelvis are disproportionately more frequent than in the habitual form; the thorax, too, may exhibit considerable asymmetry, which, however, need not be connected with the skoliosis as such.

The prognosis depends, in the first place, on the fact as to

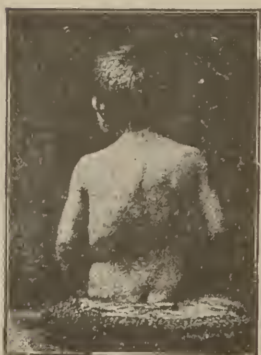


FIG. 125.—Rachitic (left-sided) Skoliosis in a Boy aged Four Years.

FIG. 126.—Slight Static Skoliosis by Shortened Growth of the Right Leg through Infantile Paralysis.

FIG. 126 a.—The Curvature Compensated by the Addition of a Sole.

whether the rachitic process is still active or has run its course. In general the prognosis is very unfavorable, owing to the age of the infant; in older children of from four to eight years the prospects from treatment are good.

The term static skoliosis is applied to a primary lateral lumbar curvature which occurs in consequence of depression of the pelvis (*e. g.*, by shortening of one lower extremity), one, therefore, which is a sequel of a disturbance of equilibrium or of effort at compensation. This variety includes Bouvier's hemiplegic total skoliosis, the ischiadic total skoliosis with the convexity of the flat curve to the healthy side described by

Albert, skolioses in consequence of large tumors of the upper extremity, etc.

A great many diseases—arrest of growth, paralysis, osteomyelitic, etc., affections, genu valgum, talipes, etc.—may cause a shortening of the extremity with resulting obliquity of the pelvis, and, through the efforts at preserving the equilibrium, bending of the lumbar spine with the convexity to the depressed side of the pelvis occurs. The observations of Hunt, Cox, Wight, Garson, Roberts, etc., show that unequal length of the extremities is very frequent, the measurements having been made both on the living and on skeletons (Garson). Garson, in measuring the skeletons in the Museum of the College of Surgeons, found the extremities equal in only ten per cent. The variation ranged from one to thirteen millimetres.

It was formerly believed that static skolioses never became fixed, that the night's rest, etc., always effected compensation, and that the graver affections of the extremity limited the function of the leg altogether too much to give play to the static factors; but this is not true for all cases.

It depends upon the duration of the disturbance and the age of the patient whether the curvature will become fixed, *i.e.*, whether permanent anatomical alterations will ensue.

The signs of static skoliosis are easily recognized on inspecting the patient from behind. The physician should sit behind the erect patient and placing his hands on the iliac crests he should determine whether there is any real depression of the pelvis.

Another way is to place the patient by a table and to compare the height of the two anterior superior spines over its edge, when it will be easy to recognize any obliquity of the pelvis and to ascertain the degree of shortening of the one leg by placing a board underneath the foot. The shortening of the extremity may also be ascertained with a tape measure in the horizontal dorsal decubitus, or by a plumb line dropped in the erect position from the anterior superior spine.

Busch [51] measures with a horizontal board having a semicircular segment cut out and provided with a spirit level; the board is accurately applied to two corresponding points of the pelvis, when the deviation of the air-bubble will indicate the obliquity.

The importance of treatment, especially in beginning lateral spinal curvatures, should not be underestimated.

Owing to the great frequency of habitual skoliosis, prophylactic measures are urgently demanded, which implies, of course, some radical changes in our present system of education, especially in girls of the so-called higher classes. While boys, with all the exorbitant demands made on them, still exercise their muscles in their leisure time by tussles on their way to and from school, as well as by walking, swimming, skating, etc., it is different with girls. The latter, even before they attend school, are accustomed to a sedentary mode of life, and with the advent of the school age their training becomes of the faultiest possible nature. The hours of instruction follow in long succession and in the intervals the girl is taught knitting, embroidery, crocheting, etc. The children have barely sufficient time for lunch which must be consumed hastily, for they must hurry back to school, carrying a heavy bag packed with a great many unnecessary books, sit in an over-crowded room, and, when evening arrives, they reach home tired, but must at once prepare their home studies or the mother urges them to practise at the piano. "Modern" children have no more time for playing, jumping, and running in the open air, etc.; the older they grow the greater becomes the number of subjects of instruction, and the less "proper" is it that pupils should be seen romping in the street. If sent to an institution or boarding school, then even the hours of recreation and class walks acquire an almost cloister-like character, which gives them a greater resemblance to a task than to a real recreation.

Although in boys we must grant that all the studies, examinations, etc., open a way to definite professions, and aim at preparing them efficiently for the struggle for existence, in girls, however, we must admit that the examinations, etc., in female colleges are more for the purpose of making an impression, of satisfying maternal vanity, and Lorenz and others justly declare that physicians should never cease to protest against a mode of education which is productive of such a frightful percentage of bodily deformity, even to the extent of crippling growing young womanhood. We must aim for a reduction in home tasks; at least three or four times a week instruction should be given in gymnastics which should consist

less in certain exercises of force or skill than in drill without apparatus; lessons in swimming, common games in the open air, instruction in natural history, geography, etc., with associated excursions, these should be included in the education of our girls. Both parents and teachers must watch over the correct attitude of the children; occupations tending to oblique position (embroidery at the frame, ironing, violin playing, etc.) should be avoided, and children should not be allowed to carry their younger sisters or brothers.[52]

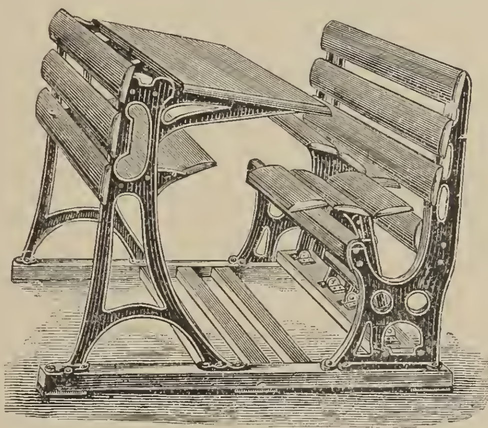


FIG. 127.—School Desk and Seat after Lickroth. The Seat Slides Back on Pising.

When at study, special stress should be laid on a correct position during writing, etc., and now that well-constructed school seats can be obtained (Fahrner, Kunze, Erismann, etc.), a step has been taken in the right direction to guard against habitual oblique position. A correct school seat should answer the following demands: the distance between desk and seat should correspond to the size of the child, and this should amount, in girls, to $\frac{1}{7}$, in boys to $\frac{1}{8}$ of the height of the body, so that the edge of the desk do not reach above the pit of the stomach; the seat should have the proper height ($\frac{2}{7}$ the height of the body, according to Fahrner); the top of the desk should have a slight inclination; the back of the seat should be suitable, preferably one inclined backward with corresponding projection in the lumbar region, or a curved back, or a lumbar rest.

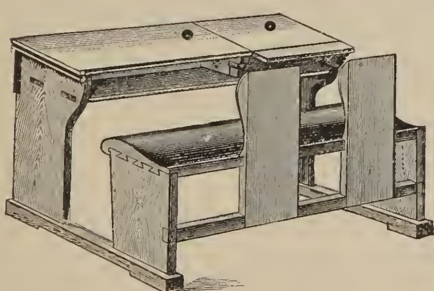


FIG. 128.—Normal School Seat.

The number of desks constructed on these principles is already very large and nearly every exhibition shows alterations and improvements. We must always remember that these changes remove only a part of the objections, and we must emphasize the necessity of sufficient intermissions in instruction, change from sitting to standing, etc.

At home, too, attention should be paid to the correct position of the children, and since modern chairs, even if made higher by a hard cushion, are hardly suitable for children at work, it is preferable to give them chairs specially made for them, such as those devised by Staffel,[53] Lorenz,[54] and others, and which are constructed with arm-rests (Pansch [55]).

Staffel's chair takes the place of a domestic school seat, as it is only necessary to place on a table an ordinary desk top to make the apparatus complete. With some slight alterations it is suitable to children of all ages, and its distinguishing feature is a back-rest, convex in front, corresponding to the normal lumbar curvature, four to five inches high, intended to reach in general from the upper edge of the sacrum to the lower dorsal vertebræ. The height of the chair is calculated for the average height of our tables, and as the child grows the legs of the chair and the foot-rest are correspondingly shortened and the depth of the back-rest is regulated every two years.

Lorenz's work-chair has a back-rest reaching to the upper end of the dorsal vertebræ, inclined backward at an angle of 100°, and curved to correspond with the normal spine; it is covered with cloth or plush. A movable foot-rest is adapted to the front legs. The height of the chair is determined by measuring the distance of the olecranon, the elbow being bent to the surface of the seat and deducting this figure from the known height of the table; by pushing the chair under the table this distance can be easily made negative. Lorenz has also made his chair adjustable, both as regards the height and the back-rest; the several slats of which it is composed can be taken off and regulated, as also the foot-rest.

Others combine the back-rest with a holder carrying axillary crutches for keeping the sitter straight (Kuhn,[56] Vogt,[57] Fürst). Children disposed to skoliosis should also during the day be made to rest for a time in the horizontal position on a well-upholstered hair mattress; for the first indication is un-

burdening of the spine whose resisting power is weakened, and special care should be taken that the child have a suitable bed. It is best to advise the use of a hard mattress with a low wedge-shaped bolster for the head, since feather beds and particularly high bolsters easily lead to a skoliotic curvature.

Further, it is certainly advisable that physicians skilled in the recognition of commencing skoliosis should be attached to schools and should examine the children several times during the year (Lorenz) in order to inform the parents as to the existence of the affection.

As to the actual treatment of skoliosis, which, of course, should be instituted as early as possible, the object is to shift the unilateral weight-pressure, to unburden the spine, and we may distinguish dynamic and mechanical methods. Each of these has its advocates, but usually both methods should be combined, and neither should be employed exclusively.

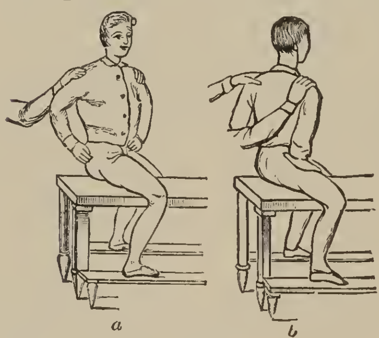
Unquestionably, appropriate gymnastics are very effective in commencing skoliosis and are not only invigorating to the entire system but act especially on the curvature. In children particularly, by means of certain movements and exercises, we can work against the curvature, and counteract any fixation. In the main those positions and movements should be practised which tend to a compensation of the curvature, and the children should often exercise "self-righting." We should particularly recommend exercises with rings hanging from the ceiling which, under certain conditions, may be at unequal height, also on the horizontal pole, trapeze, ladder, etc., especially hanging by the arms with backward curvature, then forward and backward flexion from two rings hanging from long ropes the feet being fixed, circling with the rings, forward flexion between two vertical poles, upward climbing with the hands on the back of the oblique ladder (Busch)—all these are appropriate exercises; so are the lateral (left) raising of the weighted arm, the unilateral deep breathing (the left arm being raised over the head, the right resting on the hip) recommended by Schildbach.

In view of the fact that skoliosis does not occur in persons who, like the English milkmaids, washerwomen, etc., are accustomed to carry loads upon the head, Sayre recommends bringing the patients into a straight position by making them

walk about for some time, at intervals during the day, with a book on the head, thus forcing them to balance the head.

In this connection, mention should be made of the self-suspension recommended by Lee, which is performed for fifteen to twenty minutes several times daily on an occipito-mental strap, with or without the aid of the arms; or, better still, lateral suspension, the so-called self-redressement by lateral suspension (Lorenz[58]).

Busch,[59] Eulenburg,[60] Roth,[61] Saetherberg, and others have also ascribed great importance to Swedish gymnastics with associated opposed movements. These include, with the assistance of a specially trained person, different simple or complicated manœuvres—rising from a suspended horizontal position, dextro- and dorso-flexion with raised weighted-rod, etc.—the details of which can be found in the works cited. Figs. 129 a and b show, for instance, the passive torsions of the trunk in the straddle seat. These exercises are to be practised with military accuracy and have a terminology of their own (of which I give only a few, *e.g.*, left-right-stretch-seat, right-stretch-walk, left-support-walk, dorsal-right-lateral-flexion, etc.), and are intended to indicate the exact movements which set some special muscular areas into isolated action.



FIGS. 129 a and b.—Prophylactic Gymnastics. (After Roth.)

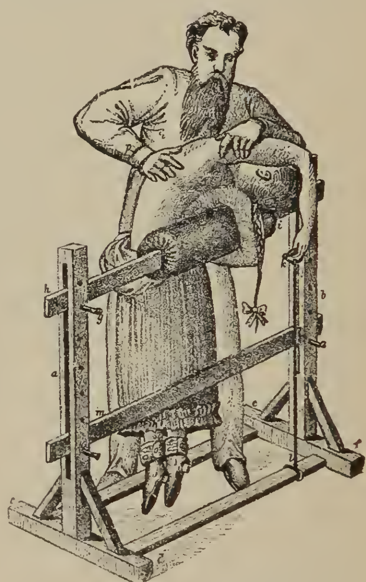


FIG. 130.—Replacement of Skoliotic Dorsal Spine by Lateral Suspension and Weighted Feet. (After Lorenz.)

Great importance attaches also to passive corrective move-

ments, such as diagonal pressure in stretched suspension, high chest suspension, straddle seat, etc., and particularly lateral suspension over a peculiar apparatus according to the method recommended by Lorenz and represented in Fig. 130. (Any carpenter can easily construct the requisite simple apparatus.)

Between two vertical posts, *a, b,* about four feet high and forty inches apart, resting on the frame, *c, d, e, f,* is a cross piece, *h,* which can be set at any height by wooden pins, *g.* The centre of the cross piece is given the form of a half-cylinder by superimposed slats and is upholstered with horse hair or covered with velvet or plush. The half-cylinder, *i,* is about thirty inches long and five inches broad. One cross rod of the frame carries a leather strap, *l,* with a handle, *k,* which may be buckled at any desired height. (A cheap substitute for the apparatus may be formed by fastening a cross piece, upholstered, between two door posts, together with a long rope tied to a screw hook in the floor.)

The patient grasps the handle with the left hand, places the right foot on the step, *m,* and then lies on the padded centre piece so that the prominent crest of the ribs, *R,* bears with its greatest convexity vertically on the pad. Thus the skoliotic trunk is suspended, as it were, upon the costal eminence, and when the patient allows the foot to glide off the step, the body represents a two-armed lever, so that the recurvation is effected with a force corresponding to the weight of the body, and this weight may be increased by suspending bags of shot from the ankles, *o o,* after the patient has become accustomed to the lateral suspension. Lorenz points out that lateral suspension should not be entrusted to the child before it has become accustomed to the correct placing of the trunk, and that the position is correct only when the right diagonal diameter of the thorax is vertical to the pad. The hand of the physician may increase or modify the force. Lorenz also states that the first attempts are painful, that disturbed respiration is sometimes present, and that weeks elapse before the patient becomes sufficiently accustomed to the procedure to bear it with comparative ease.

Beely [62] has devised a very simple apparatus, essentially in the shape of a long, right-angled frame. Resting on two stout posts, it may be revolved around a central axis, has superior cross rods to be grasped at different heights by the

patient, and has two movable pads which can be so applied to the body as to effect diagonal recurvation. By depressing the upper part of the longitudinal frame, the force exerted by the weight of the body can be graduated, and the length and frequency of the exercises are regulated by the endurance of the patient.

Shaw devotes a chapter to the consideration of the proposition to cure curvatures of the spine by friction, kneading, and shampooing, together with a picture of a special frictional roller. The advocates of the myogenous theory of course claimed that massage with electricity and gymnastics were deserving of the first consideration and these means have also been employed in suspension (P. Vogt). Of late, this plan has been again warmly recommended, especially in the form of pounding and rubbing of the dorsal muscles on the two sides—massage of the thorax.

Landerer[63] thinks it important that the physician should perform the massage himself and reports striking results after several weeks' treatment; so do Kölliker and others. It is advisable to cause the patient to wear a corset in the intervals.

In order to strengthen the weak dorsal muscles which allow the habitual lax attitude, the faradic current has been recommended (L. Vogt and others), not only for the production of vigorous contractions of the dorsal and thoracic muscles with the associated increased contractility and nutrition, but also for obtaining appropriate positions and movements in isolated portions of the spine.

Important as these methods are from the standpoint of prophylaxis, and in the treatment of commencing skoliosis and in mobilization of advanced, little effect can be expected of them in fully developed cases. In the latter, mechanical auxiliaries must be resorted to which are based either on traction and counter-traction or pressure and counter-pressure. They may be divided into couches and portable apparatus (corsets, etc.).

It is of the utmost importance to utilize the night's rest in the treatment (all the more because one disturbing element, weighting, is eliminated), and the first care should be to provide a hard mattress.

A simple device for overcoming the curvature is the Lonsdale-Barwell suspensory sling (the suspensory belt) (Little,

Schildbach, Busch[64]). This is a sling hanging by a rope from the ceiling at the proper height over the bed, into which the patient places himself on the convex side, whereby pressure is exerted in a correcting diagonal direction or a lever effect is produced. Busch and Wolff have modified the method of lateral pressure by a suspensory belt, by applying the belt, hand wide, to a special support (a base board with two pair of obliquely ascending iron rods), thus making a suspensory frame.

Its only drawback is that its effect is at once nullified if the patient turns in it.

Rest for several hours daily in a hammock can also be used; for instance, in right-sided deviation the patient should

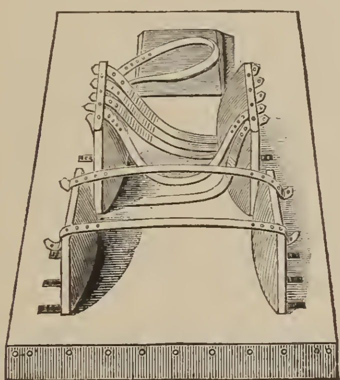


FIG. 131.—Beely's Couch for Skoliosis.

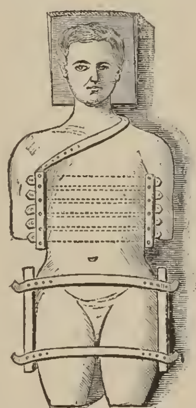


FIG. 132.—Beely's Couch. (Representing the Position of the Patient.)

lie with the left side down, thus changing the concave side into the convex, that is, reversing the condition.

Next in order are the couches for skoliotics, of which the one devised by Beely,[65] represented in Fig. 131, may be adapted to any individual and may easily be made by any mechanic. In a right-angled bed, upon which the patient rests, are two excavations for the head and pelvis over which straps are stretched; four smaller boards are fastened vertically with angle-irons; two of these reach from the axillæ to near the iliac crests, two extend to the middle of the thighs, their height being equal to the sagittal diameter of the thorax.

The boards are padded on the inside and those for the thorax rest on but three points, so that straps can easily be carried under them. Near the upper outer edge each has five or six equidistant buttons for attaching the straps. Two buttons are applied to the head end for attaching a neck-strap. For a patient with right dorsal left lumbar skoliosis five straps are applied; only one of these (4) is of leather throughout, the others have a piece of stout rubber interposed. The upper straps run from right above to left below, the fourth forms a simple suspensory belt, the fifth runs from left above to right below, and when the patient places himself in the apparatus the pelvis is fixed by two transverse straps, the neck is prevented from bending to the left by a well-padded strap, and straps exert an elastic corrective pressure on the most prominent parts of the back. A low pillow may be placed under the head.

A couch which is largely used is that of Bühring—an iron plate carrying pads adjustable by screws to bear against the convexities of the curvature. Hüter's modification [66] of this apparatus still has its advocates. Schildbach used, instead of the wedge-pads, traction pads, and Staffel [67] has devised a combination of Bühring and Schildbach's apparatus. He used the wedge-pad for the lower curvature and for a dorsal pad a broad oblique belt connected with a strongly curved steel spring; all these parts are adjustable, as is a third padded brass plate. When the straps are buckled, the spring acts, the pad is pressed in front against the ribs and a rotatory effect is produced by the combination.

A variety of apparatus acting by traction and countertraction has been constructed since the time of Hippocrates, in the shape of the extension beds of Venel, Heine, Valerius, Moncour, Guérin, Bouvier, Pravaz, Major, Coles, and others. On these the poor patients were formerly tortured for years without effect, so that Wildberger justly condemned them. From the large number we select only that devised by Heather Bigg, which will be readily understood from Fig. 133 and which permits at least some movements, while the elastic appliances exert constant traction, correcting the curvature; and we also show the simple extension frame of Beely [68] which may be used in connection with other methods (in the intervals of rest). (See Fig. 6.)

The numerous orthopedic chairs devised since the time of Levacher de la Feutry have merely an historical interest.

Of importance, especially for static skoliosis, is the antistatic treatment which aims at a correction of the lumbar or

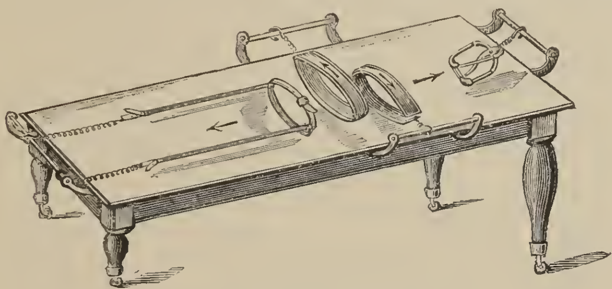


FIG. 133.—Heather Bigg's Extension Bed.

other curvature by causing an oblique position of the pelvis. By the interposition of a cork sole, not over one and one quarter inches thick, on the side of the convexity (*e.g.*, on the left in left-convex lumbar curvature) the pelvis is made to incline to the right and the curvature is compensated; but care must be taken lest bending of the knee counteract the effect of the measure. This method of course is applicable only to mobile skoliosis.

Lorenz[69] has attained very effectively the simultaneous correction of the dorsal and lumbar curvature in the erect

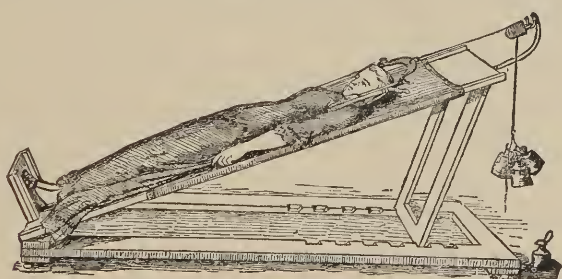


FIG. 134.—Beely's Extension Frame for Skoliosis.

position of the patient as follows: A well-padded pelvic fork, fastened at the proper height in a vertical post, grasps the pelvis of the patient at the level of the spines and is closed by a padded strap.

By placing the left foot on a rest one to one and one-half inches high, the pelvis is depressed on the right, the left-convex lumbar skoliosis is bent back, and the thorax being surrounded by a padded belt and fastened to the vertical pole, is pressed to the right and the head is inclined to the same side. It is thus possible to attain correction, and after frequent repetition and intensification of the belt action, the dorsal skoliosis may be even slightly over-corrected. By weighting the shoulders by a collar filled with shot (60 to 65 lbs.), a marked over-correction can be effected (the line of spinous processes being closely watched).

In the sitting position, particularly, it is possible to attain the desired end by elevating one half of the pelvis. Volkmann and Barwell have devised for this purpose the well-known oblique seat (Fig. 135) to which Vogt has added a suspender. This seat may be improvised by a wedge-shaped oblique cushion. According to Staffel, this apparatus can be easily made portable by being attached to the corset in the shape of a small wedge-shaped bolster.

FIG. 135.—Volkman's Oblique Seat.

König and others recommend testing the effect of the oblique seat on the back of the patient before advising its continued use.

A lady's saddle also represents a similar oblique plane and under certain conditions riding is considered appropriate in the treatment of skoliotic female patients.

The large group of portable apparatus, the corsets and girdles, which merely keep the spine extended or are intended to act by measures (pressure and counter-pressure) specially directed toward correction, must be conjoined to the above in the more highly developed forms; but we must not restrict ourselves to their use and neglect gymnastics, etc. The number of skoliosis apparatus is enormous and their close description would fill volumes; I therefore must restrict myself to some in present use, especially since Fischer[70] has only recently published a careful synopsis in historical order, to which the reader is referred.

The apparatus which acts by elastic traction devised by Barwell[71] has the advantage of great simplicity; but it can

only exert elastic lateral pressure, and has no torsional power.

In the elastic traction apparatus (the oblique bandage) constructed for habitual skoliosis, the line of traction, rendered elastic by rubber bands, is from the left trochanter to the projecting portion of the ribs and from there to the left shoulder. The latter, as Busch points out, may have an injurious effect by drawing the left shoulder with the entire trunk to the right side—an evil which Heather Bigg tried to overcome by adding an axillary crutch ascending on the left side.

In Barwell's elastic spiral bandage, which starts from the region of the right trochanter where a soft leather pad is fastened by a perineal belt, passes obliquely over the abdomen to the prominent ribs and thence to the left shoulder, encircling the body spirally, there is not a sufficiently fixed point for the force to act. Sayre's [72] modification of Barwell's oblique bandage—of which the author himself says that it is rather a monitor to the patient—and which consists of the addition of other elastic lines of traction, two perineal straps, etc., will hardly make the apparatus more useful, exerting as it does a correcting elastic lateral pressure, but no rotatory power.

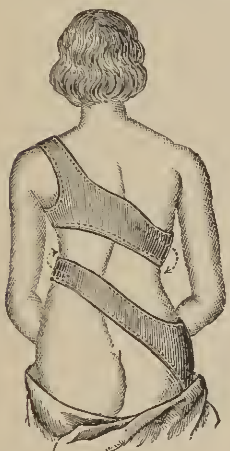


Fig. 136.—Barwell's Spiral Bandage for Skoliosis.

By his elastic spiral bandage (which has not yet been sufficiently tested in practice) E. Fischer applied elastic torsional traction immediately to the body. The apparatus draws the shoulder corresponding to the convex outward curvature (hence usually the right) downward and forward, and by increasing the pressure on the convex side, restricts its growth.

The contrivance has the advantage of being cheap, easily constructed, permitting gymnastics, massage, etc., while causing hardly any pain from pressure, etc. It consists of a leather (right) shoulder-holder, narrow in front, becoming rounded, and deeply cut out, which is intended to reach the mid-line and to cover below the outward curved portion of the spine; it is fastened by an elastic bandage around the shoulder of the concave side (left)—Fig. 137—whereby this (left) shoulder is

steadily drawn backward but not downward. From the shoulder belt two elastic bandages pass which leave the (right) breast free, extend over the abdomen to the (left) thigh where

Fig. 137.—Fischer's Spiral Bandage, Applied with good effect to the Girl Represented in Fig. 119.

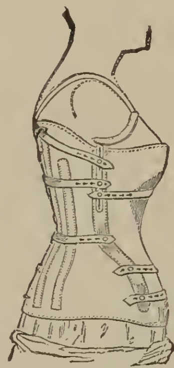


Fig. 138.—Beely's Supporting Apparatus, Lateral View

they are fastened so that when the left hip is lower the pelvis is constantly kept straight.

The great majority of the numerous skoliosis appliances consist in an upholstered pelvic belt which forms the point of

Fig. 139.—Beely's Corset.

Fig. 140.—The Same, Rear View.

support; it rests above the anal fold between the iliac crest and trochanter (occasionally with special auxiliary supports above the crests), and is buckled in front over the symphysis pubis.

From this ascend, either behind or also laterally, one or two steel splints, to the former of which are fastened belts or pads for the correction of the costal eminence, and to the latter axillary crutches (props) for stretching the spine. Hossard, Tavernier, and others have been mainly instrumental in the introduction of the corset treatment.

Particularly for slight cases is it advisable to use, in addition to appropriate gymnastics, massage, etc., simple supporting apparatus for the spine—corsets made of strong material, fitting well at the waist, and supplied with whalebone or steel plates and arm props. Fig. 139 represents a suitable corset of the kind devised by Beely,[73] Fig. 140, the same seen from behind; while Fig. 138 represents the mechanism for the gradual elongation of the lateral splint. According to Beely, it is sufficient in most cases to model only one lateral splint (for the convex side of the thorax) and have the other made exactly symmetrical; in grave skolioses a special model must be made for each side, and the length of the arm props be exactly regulated.

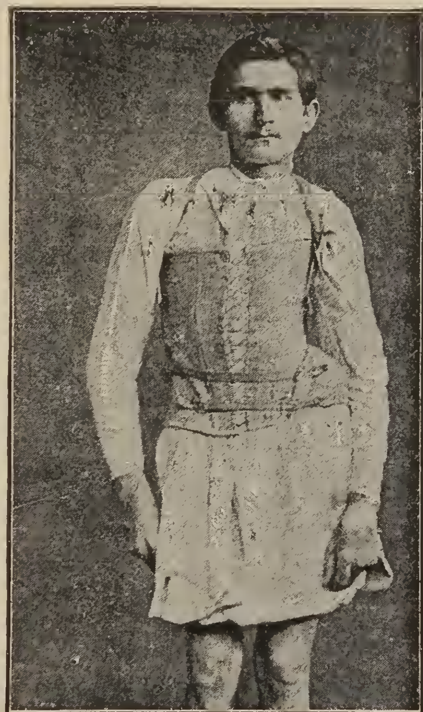
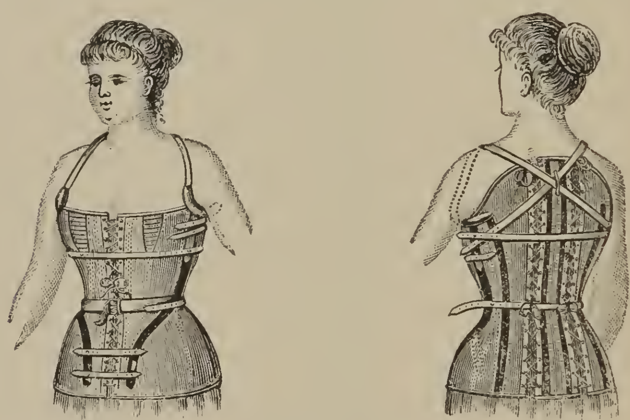


Fig. 141.—Beely's Supporting Corset in a Case of Grave Skoliosis (Comp. Fig. 182).

Beely's axillary props are rarely lengthened behind above the lateral splints, and in fact consist merely of the anterior half of the ordinary form of axillary crutch, and end in axillary straps; they are made either of quarter-inch iron wire padded with soft felt so as to be still slightly flexible, or of square steel rods, in which case they must be given their per-

manent form before being hardened. The lateral splints, about one-half inch wide, one-eighth to three-sixteenths inch thick, carry only the extensible arm prop; they are but slightly elastic, pass vertically down from the centre of the axilla, and above the crests of the ilia are bent forward.

The back of the corset is provided with vertical elastic steel splints of varying length and thickness, so shaped as to exert a correcting effect on the most prominent parts. At the upper end of each lateral splint are three, at the lower ends two buttons, and at the level of the waist one on each side, which serve for fastening the back straps, breast straps (below the mammæ), and two abdominal straps (uniting the



Figs. 142 a and b.—The Latest Form of Beely's Corset for Skoliosis.

ends of the lateral splints). In front and behind the corset is made to lace; the anterior splints on each side of the lacing openings consist of three parallel steel wires one-sixteenth of an inch in diameter, inserted above and below in a small metal sheath; they bend in any direction and hence are always closely applied to the body.

Where necessary, elastic traction may easily be added over the greatest convexity.

The latest modification of Beely's corset, Figs. 142 a, b, has two lateral splints which are joined only on the left side by the crutch; the dorsal splints are almost inelastic in the middle, very flexible above; at their lower end they are flat; the lateral splints are strongest at the waist. The upper, median,

and lower parts can be laced unequally tight (the median portion to the greatest extent).

The belt originally devised by Hossard aimed only at redressing the deformity, offered no support to the spine, and could be of slight use only in simple skoliosis, but would be rather injurious in more complicated forms (Bouvier, Volkmann).

Hossard's belt in its simplest form consisted of a broad, well-padded pelvic belt; from its posterior portion ascended a stout median iron rod as far as the shoulder; it was movable by a toothed wheel, could be fixed to the right or left, and carried small buttons on its posterior surface. The buttons served for attaching padded leather straps which passed in a semi-spiral from behind over the prominent shoulder blade and the costal eminence to the front, where they were buckled. The steel rod was to be so adjusted as to bring its upper end to the side of the dorsal convexity alongside the spine, crossing the latter obliquely; the straps in the ordinary habitual skoliosis were to be so drawn as to shift the entire thorax to the left.

Tamplin [74] modified the apparatus by adding an axillary prop on the concave side of the curvature.

Guérin [75] put a hinge into the posterior rod and added a corresponding anterior splint, so that the strap between the upper portions should act on the dorsal curvature, that between the lower portions on the lumbar curve.

Mathieu's apparatus, similar to that of Duchenne,[76] devised especially for skolioses succeeding muscular paralysis, represents a belt acting by elastic cords; the lower shoulder is raised by an axillary prop, and the deviation is counteracted by elastic straps which may at will increase the inclination of the posterior steel rod and thus press the broad belt against the dorsal convexity.

Additional more complicated modifications have been devised by Charrière (*ceinture à pression continué*), Wales, and others.

In Brodhurst's apparatus the movable dorsal rod is united with the axillary props in the region of the shoulder blades, from it extends a lever with large pad to the side of the convexity where it exerts inward pressure, while the lower shoulder is surrounded by a well-fitting cap of rubber which is fastened behind to the upper end of the dorsal rod.

Volkmann[77] recommended, especially for slight unilateral skoliosis of static origin, a simple apparatus which consists, in ordinary right-sided skoliosis, of a pelvic belt with left thigh splint, left axillary prop, and a median rod with slight spring action to the left. From the upper end of the latter an elastic belt, broad enough behind to inclose the entire prominent part of the back and the shoulder blade and then becoming narrower, passes over the abdomen and the left crest of the ilium to the pelvic belt, where it is fastened behind the trochanter, so that the apparatus exerts a slight rotatory effect.

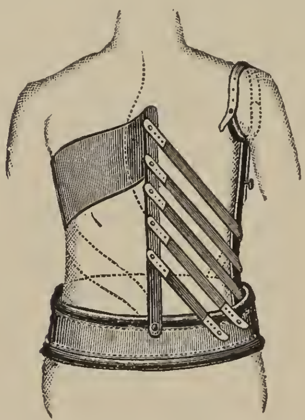


FIG. 143.—Mathieu's Modification of Hossard's Belt (for Left-sided Skoliosis).

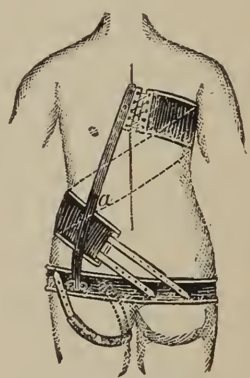


FIG. 144.—Staffel's Belt.

Finally, a very simple and practical modification of Hossard's belt has been devised by Staffel.[78] He employs a spiral rubber bandage, the broad end of which springs at a right angle from the upper end of the vertical mast which follows the outlines of the body. The bandage curves around the prominent (right) dorsal side, passes in front obliquely over the abdomen to the opposite (left) side, which it surrounds, and is fastened behind by two straps. The mast may be applied either at the posterior centre of the pelvic belt or to one side, as it can be shifted along a slit and fastened by a thumb screw so as not to interfere with bending of the body. A spring piece, *a*, is placed in the mast at about the level of the lumbar curve, while the upper end rests against the back with slight elastic pressure. A thigh strap prevents upward dis-

placement of the pelvic belt on the left side, and where the height of the shoulders remains uneven, an axillary prop is added on the concave side.

In place of the median rod, Eulenburg, Heather Bigg, Chance, and others recommended two masts adjustable by an endless screw to which the correcting straps or pads are fastened.

One of the most extensively used appliances is that of Goldschmidt-Eulenburg (Fig. 145) with spring axillary props,

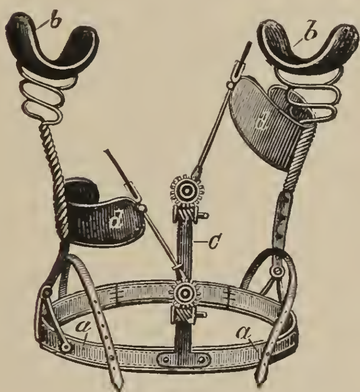


Fig. 145.—Apparatus for Skoliosis. (After Goldschmidt-Eulenburg.)

Fig. 146.—Schildbach's Lateral Traction Machine.

b; behind it carries a stout steel splint, *c*, reaching exactly to the centre of the back and fitting closely to the body, at the middle and end of which is a toothed-wheel. From these ascend to the right and left round steel rods which can be given a lateral motion by turning the screws with a key and which carry the two pads, *d*, for surrounding the convexities. The pads are movable forward, backward, up and down. The apparatus may be stitched into an ordinary corset, does not annoy the patient, extends the spine by the spring axillary props, and is intended to redress the curvatures by the elastic pressure of the pads. One modification substitutes elastic straps for the pads.

Another group of apparatus, like Schildbach's portable

lateral traction machine, applies the traction or pressure more in an oblique direction.

In ordinary right-sided skoliosis the left shoulder is raised by an extensible axillary prop which forms with the pelvic belt an angle open to the inside, so that, before the chest straps are laced, the upper end points away from the thorax; after being laced an elastic lateral traction is exerted from right to left. A strap carried over the left shoulder is to prevent deviation of the pelvic belt.

Lorinser's [79] apparatus is also intended to crowd the convexity of the dorsal vertebral curvature toward the middle line by elastic traction. To the pelvic belt is adapted a splint, movable on a hinge, along the opposite thigh (the left in right-sided dorsal skoliosis), which reaches to the axilla and when fastened to the thigh by straps it tends to deviate to the left above. If fastened above by a broad leather belt which surrounds the prominent (right) side and below over the abdomen to an iron tongue connected with the splint, a correcting effect is exerted. Displacement of the splint is prevented by a crutch-like attachment above, and an axillary prop is also applied to the opposite side.

Another apparatus having mainly a lateral effect (hence unsuitable where torsion is pronounced) is that of Goldschmidt,[80] in which endless screws exert pressure on two pads on racks, applied against the main curvatures, thus aiming at reduction.

Of more importance are the numerous apparatus acting also upon the torsion.

Langgaard's [81] apparatus consists of a well-padded pelvic belt composed of two parts and closed in front by a hinge; it rests by two steel arches on the crests of the ilium. On the concave side is an adjustable steel rod with axillary crutch and from it extends a jointed spring arm. At the end of the latter is a pad adjustable by a ball-joint to any portion,[82] intended both to redress the torsion and to exert direct pressure on the projecting parts; it is moved by an endless screw. For producing counter-pressure, a steel rod is on the convex side with interposed spiral spring for adapting it to the movements of the arm; at its extremity is a rounded pad for the anterior region of the shoulder. Straps passing over the shoulders help to fix the apparatus.

The apparatus devised by Heather Bigg[83] also has pressure pads. From a light pelvic belt, somewhat oblique in front, corresponding to the inclination of the pelvis, ascend one or two posterior, well-padded steel splints which carry, at the level of the shoulder-blade, a cross rod with two curved portions which surround the axillæ. At the proper height of the dorsal splint, pads are fastened which exert a redressing effect, through spring or screw pressure, on the deviations. Chance has devised a simple apparatus, largely used in London, which for slight cases consists of a pelvic and lumbar belt,

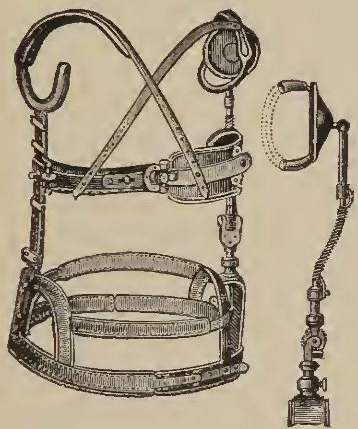


Fig. 147.—Apparatus for Skoliosis. (After Langgaard.)

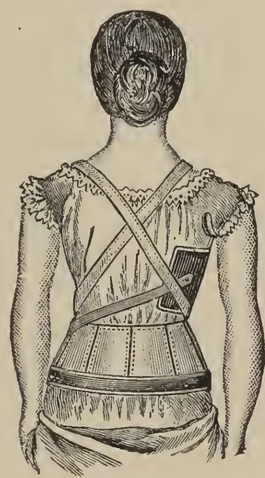


Fig. 148.—Apparatus for Skoliosis. (After H. Bigg.)

median dorsal splint and pad against which the shoulders are pressed; for graver cases two pads are added for the dorsal costal eminence.

Another apparatus, devised by Heather Bigg for grave cases, acts mainly on the torsion and aims at twisting the thorax on the pelvis by means of a spring ascending on the left from the broad pelvic belt across the mid-line to the right above, which presses by a broad pad upon the right costal convexity. Aufrecht with his apparatus endeavors to press by one pad the posteriorly projecting right shoulder forward, and the forward protruding left shoulder backward by another pad (Fig. 149).

Of the numerous pad corsets, Nyrop's spring pressure machine[84] is justly one of the most popular and is preferable to others also on account of its slight weight.

The apparatus consists of a pelvic belt from which ascends in the mid-line of the back an iron rod which carries above, on an adjustable cross-piece, two axillary crutches ending in straps for fixation. To the dorsal rod are fastened an equal number of steel springs tending outward, *i.e.*, convex in front (they should preferably be compound springs), each of which carries a movable pressure pad and these are fastened in front by straps so that the pad exerts a correcting action on the convexity. For the lower (left) shoulder the machine is supplemented by a lateral splint which, according to Jessen's proposal, should be forked below and be arched over the iliac

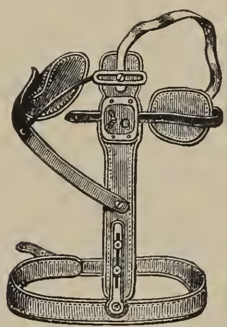


Fig. 149.—Apparatus after Aufrecht.

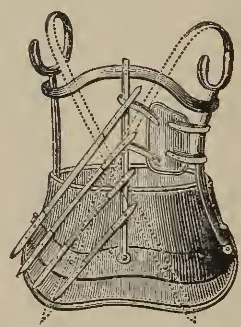


Fig. 150.—Corset after Trélat.

crests, being fastened at the pelvic belt. The lumber pad may also be replaced by an elastic strap with corresponding obliquity. Vogt and others prefer Nyrop's corset to any other. As for the good results attained with this apparatus, the reader is referred to Nyrop's paper.[85]

Collin's apparatus (with pelvic belt, lateral axillary props united by a metal frame) is also provided with devices for exerting elastic pressure on the projecting parts of the body, similar to the apparatus of Trélat and Le Fort, the lower parts of which consist of pliable sheet copper closely fitting the body, or of shaped leather.

Some of these apparatus may also be looked upon as modifications of Hossard's belt, like Mathieu's apparatus after Trélat, represented in Fig. 150.

Staffel,[86] too, has recently devised a pad corset which, for the common (right-sided) skoliosis, consists of a pelvic belt of sheet steel, an axillary prop for the lower (left) shoulder, and a splint extending from the (right) posterior circumference of the pelvic belt, adjustable by an endless screw, and provided above with a hollow pad; in other respects it is a strong whalebone corset to be laced in front. By means of it we can exert any desired pressure on the posteriorly projecting ribs, and thus produce a forward twisting effect; while the right shoulder band being drawn tauter, the higher shoulder is depressed.

In the latest corset of Nyrop, which he much prefers to the plaster jacket, the apparatus is provided with appropriate (jointed) steel springs capable of exerting pressure on the body from without inward. The apparatus is removable, but may be worn day and night; it may also be easily combined with Levacher's swing, as may be seen from Fig. 95. The apparatus fits the body as closely as a plaster jacket, and thus in many respects resembles the above-described corset of Beely.

We may gather from the large number of apparatus for skoliosis that their corrective effect is by no means prompt, and some authors (Sayre, Dally) reject them all. Sayre at all events goes too far in rejecting all such apparatus as useless and as merely forcing the patient to bear horrible torments.

At any rate, their disadvantages—that they are expensive, cannot be used long, and need frequent repairs—are apparent in most of them, and hence it is easy to understand the delight which greeted Sayre's announcement that he had found in the plaster corset applied in suspension a method of treating skoliosis which was accessible to any physician.

But soon the original enthusiasm gave place to sober afterthought, and nowadays all that can be said is that the plaster jacket, applied in specially redressed position and made removable, is of importance in skoliosis only when used in connection with other treatment. Plaster jackets worn too long may act injuriously by causing atrophy of the muscles, etc., and, important though they are for kyphosis, they are unsuitable to slight skoliosis, and Dollinger[87] has demonstrated by measurement an increase of slight skolioses in the plaster jacket. Constructed as removable retention dressings, however, they are of importance in severe cases, seeing that

they liberate the thoracic and abdominal organs from the weight of the trunk, and facilitate the equalization of the circulation. The plaster of Paris, however, should act here only as an adhesive material for the bandages and merely be rubbed into the gauze rollers (about three and one-half inches broad). The plaster mass cannot be employed; and the dressing, which is applied over a tight-fitting stockinet shirt, has decided advantages over others in that it sets rapidly.

Silicate of soda corsets have the advantage of being more durable; but the first bandages applied over the stockinet shirt must be well wrung out, otherwise the silicate penetrates into the shirt, making it hard and rough, and possibly giving rise to excoriations, etc.

The application of the corset in suspension is not as handy as in the hammock method or in reduced lateral position (Dornblüh, Petersen,[88] Fränkel).

Petersen places the patient as follows: The legs are supported on a table as far as the trochanters, the head rests on a pillow on another table, the trunk is supported only at the greatest convexity by a Barwell's sling, *i.e.*, a triangularly folded cloth the ends of which are fastened to a cross rod which is drawn up or let down by pulleys. After the position has been corrected or over-corrected and the spines padded, the sling is included in the plaster dressing and the ends are cut off.

Lorenz has devised definite methods of applying removable plaster dressings for the several forms of skoliosis; they are intended to supplement the result attained by methodical correction and to maintain position; thus, for primary dorsal curvature there is the lateral traction dressing and pressure dressing (the former, of course, acts only against the lateral curvature of the spine, leaving the costal curvature out of consideration, while the latter is specially directed against the ribs).

The lateral traction dressing (Fig. 151), *i.e.*, a plaster dressing fixing the trunk in left displacement to the pelvis, with the addition of traction at the thigh, is suitable to somewhat advanced primary dorsal skoliosis with considerable lateral displacement of the trunk on the pelvis toward the right. Owing to the disfigurement caused by wearing it, it is applied several hours daily at home, in such a way that the lateral

displacement is quite considerable, forcing the child to active opposite bending of the spine, while for use outside it is advisable to apply a less conspicuous dressing which causes only slight lateral displacement.

The lateral traction dressing is applied in the erect position, the pelvis of the patient between trochanter and iliac crest being grasped by a padded pelvic fork; the trunk is first brought into the desired position or fixed by a belt attached to a lateral vertical post and surrounding the thorax. The right arm being abducted, the plaster dressing is applied. It reaches above only to the point of the right shoulder-blade; on the left side it may be still shorter. The pelvic folds of the bandage inclose a two-armed tin plate having grater-like openings and bearing below a stout ring; to the latter is fastened, after completion of the dressing, a strap arising at the left from a legging laced to the thigh which serves to prevent displacement of the left lower edge of the dressing.

FIG 151.

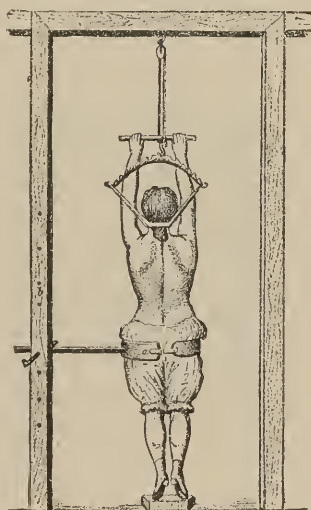


FIG. 152.

The pressure dressing, which is directed especially against the torsional changes of dorsal skoliosis, is applied by Lorenz like an ordinary Sayre's jacket; the patient being suspended in Beely's sling, and the pelvis being fixed by a fork, *a* (Fig. 152), so as to prevent rotation of the body. The dressing reaches to the angle of the shoulder-blades, the flat parts of the thorax having previously been padded with felt placed under the

stockinet shirt. Over the most prominent points thick felt pads are fastened to the inner surface of the dressing, which, when completed, is laced in suspension. Thus pressure is exerted in the right diagonal diameter, while dilatation of the thorax is permitted in the shortened left diagonal diameter.

It is easier to effect correction (or fixation of the affected segment in a position opposed to the curvature) in case of lumbar skoliosis, by using a still lower and hence less troublesome removable plaster dressing. This dressing Lorenz recommends, as the "belt dressing," for primary lumbar skoliosis, and at the same time it has a correcting effect on the commencing secondary curvature of the dorsal segment.

This dressing is also applied in the erect position. In left

Fig. 153.

Fig. 154.

lumbar skoliosis the left side of the pelvis is raised by elevating the foot three-fourths to one and a half inches high, is fixed by the pelvic fork, the trunk is inclined to the left and supported by a padded axillary crutch. This position the patient can readily maintain for fifteen to twenty minutes; then the plaster dressing is applied in the usual manner and thus the lumbar spine is maintained in a right-convex position; in left-inclination of the trunk the dressing is applied or laced from the right side.

Karewski,[89] at Israel's instigation, recommended corsets made of close-meshed galvanized wire netting, or plates for the anterior and posterior surface of the trunk, with proper openings for the arms and moulded to fit the mammæ; they are accurately fitted to the patient in suspension or other-

wise. These wire plates, the borders of which are lined with strong adhesive plaster, are united into a corset by means of a silicate of soda bandage which is applied in suspension. After twenty-four hours the corset is opened at the side and removed, when the edges are bordered with soft leather, one lateral edge is provided with hooks for lacing (with rubber cord), the other is made flexible by a stout strip of leather, and on each shoulder, front and rear, hooks are affixed for elastic shoulder straps (a piece of rubber two inches wide, with perforated leather straps at each extremity).

These wire corsets are said to be preferable to the plaster jacket on account of their better fit, light weight, porosity, and durability; only a close-fitting stockinet shirt should be worn underneath; they should be removed at night and applied in the morning in suspension.

Of still simpler material are Bernhardi's pasteboard corsets which may be reinforced with splints, and Vance's[90] paper jacket which is formed of strips of brown paper glued together.

Corsets of plastic felt have also been used. They are shaped directly on the body or on a model; but they are much inferior to steel spring corsets and are valuable only in case of skoliosis of the third degree, in which some supporting apparatus must be worn for preventing neuralgic pains; they are applied in suspension.

Deformities of the Thorax.

Pigeon breast, *pectus carinatum s. gallinatum*, is the term applied to a characteristic deformity of the thorax (with or without implication of the spine), in which the anterior ends of the ribs are bent inward, the sternum and costal cartilages project in the shape of a keel, the thorax being enlarged in the sagittal diameter, and narrowed in the frontal diameter.

The costal cartilages being bent inward with concavity directed forward, a sulcus is formed on both sides in front of the thorax.

The deformity usually depends upon rachitic softening of the bones, but other processes may be concerned in the etiology, though more rarely, and Eulenburg, *e.g.*, distinguishes:

Pectus carinatum rachiticum,
" " ex gibbositate,
" " paralyticum.

That pigeon breast is among the most frequent of rachitic deformities is shown by observations such as those of Chance, who observed 156 cases among 600. Besides primary local softening of the bones, there are a number of other causal conditions to be considered, such as those which prevent the free entrance of air into the thorax, especially attacks of spasm of the glottis associated with soft occiput (Elsässer); for in these cases the glottis does not open far enough to permit the ingress of air with sufficient rapidity to meet the sudden enlargement of the thorax by the action of the diaphragm. The air pressure then acts on the sides of the thorax and crowds the weakest portions inward (Jenner, etc.). Besides spasm of the glottis, there are other conditions in which the expansion of the thorax is not accompanied with sufficient dilatation of the lungs; paralytic states (after whooping cough, etc.) are also mentioned as etiological factors, as well as enlarged tonsils (Shaw).

FIG. 155. — Severe Pigeon Breast with Paralytic Lordosis and Kyphosis; Bilateral Spontaneous Luxation of the Hip.

Further still the lateral pressure of the arms upon the chest may play a part in the formation of pigeon breast.

With reference to the symptoms, we observe here, too, widely differing grades of the deformity, and in the higher of these the lateral flattening of the thorax with the keel-like projecting sternum and flattened costal cartilages which form a real hunch-breast constitutes one of the most terrible disfigurements (Fig. 155). The thorax at the same time is considerably shortened in its transverse and lengthened in its sagit-

tal diameter, its capacity is absolutely diminished, and hence in the graver cases some dyspnœa is rarely absent, especially if spinal curvatures coexist.

The prognosis is favorable only in the slighter grades in early infancy, since in the course of growth, after the rachitis has run its course, a spontaneous compensation of the deformity is here also possible; in the higher grades, of course, the prospects of improving the deformity will become worse.

The treatment (in addition to being anti-rachitic) must counteract the narrowing of the thorax by appropriate active exercises and gymnastics (some exercises, such as rowing, are here specially recommended) and by stimulation of the inspiratory muscles (baths, cold affusions, etc.).

Of course, circular bandaging of the thorax cannot be resorted to, but the application of weights (shot bag, etc.) to the anterior surface of the chest in the dorsal position may be tried. Passive exercises may be performed methodically several times daily and be productive of good results; only rarely will resort be necessary to more complicated apparatus which approximate the sternum to the spine by elastic pressure without touching the lateral wall of the thorax.

In comparison with pigeon breast, other deformities of the thorax are of minor importance. A characteristic deformity, also usually due to rachitis, is the *pectus excavatum* with depressed sternum or in-drawn præcordium (similar to that occurring as the result of some occupations, as in shoemakers, etc.). These varieties are entirely beyond the reach of treatment.

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CHAPTER V.

ORTHOPEDIC AFFECTIONS OF THE EXTREMITIES.

I. Contractures and Ankyloses.

The term ankylosis (from ἀγκύλος, crooked[1]) (French, *roideur articulaire, anchylose;* German, *Gelenksteifigkeit, Gelenkverwachsung;* Italian, *anchilosi*) designates that condition in which, through adhesions or other alterations within or without a joint, its mobility is partly or entirely arrested.

It is customary to distinguish complete, true, bony ankylosis, where the articulations are united by bony adhesions (synostosis) and where mobility is therefore completely arrested, and false, partial, fibrous ankylosis, in which the adhesion is effected by connective tissue and a partial mobility is retained. Some distinguish, in addition, cartilaginous ankylosis which arises mainly from inflammatory processes in the neighborhood of joints, resulting in gradual obliteration of the synovial membrane, and in which the cartilaginous layers at first remain intact, but become subsequently adherent and atrophic.

Bridge-like ankylosis is the term applied to the condition in which the ends of the articulations are united only by some flakes of bone, which usually correspond to the ossified fibrous ligaments or muscles, as for instance, the anterior longitudinal ligament of the spine, the brachialis internus at the elbow, etc.

Furthermore, we may distinguish straight or angular, simple or complicated (*e.g.,* associated with luxation) ankylosis.

In general, the term ankylosis is understood to mean the condition of absolute immobility (*immobilitas compacta*) of a joint, while diminished mobility, pathologically restricted excursion of motion (*mobilitas incompleta*) is designated as contracture (pseud-ankylosis, *rigiditas articuli*). The latter is divided into the arthrogenous, *i.e.,* that due to changes in the articular apparatus, into the neuro-myogenous, *i.e.,* that due

to alterations in the muscles or their innervation, and into the cicatricial which are caused by cicatricial processes, the contraction of cicatrices. We will speak of the neuro-myogenous contractures mainly under the head of deformities produced by paralytic conditions, etc., and we are at present chiefly concerned with the arthrogenous contractures, and with those due to pathological processes around the joint (peri-articular) which include also the cicatricial contractures.

Congenital contractures and ankyloses as the result of arrested development, or in consequence of inflammatory processes *in utero* rarely come under observation. We find, however, for instance, in the *Histoire de l'Académie des Sciences*, 1716, the description of a child aged twenty-three months with complete ankylosis of the entire skeleton.

Ankylosis is observed much more frequently in ginglymoid joints than in others; usually it is found in a single joint, rarely in several. Cases like that reported by Conner (*de stupendo ossium coalitu*), in which there was an almost universal ankylosis, are very exceptional.

As to the causes of contractures and ankyloses, they may arise gradually from simple non-use, especially in elderly persons, as has been demonstrated by Menzel,[2] Paget, Reyher,[3] and others. An interesting example is furnished, among others, by the Indian fakirs who, for the sake of penance, often remain for years in one position, and whose joints are said to become frequently ankylosed in such an attitude. In such cases, there occurs not only muscular contracture, the insertion points remaining permanently approximated, but also proliferation of the vascular synovial processes, and characteristic changes of the cartilage, especially at the points where the articular surfaces no longer touch; and here some part is also played by the first motions made after prolonged rest, which then act as an inflammatory irritation (Volkmann[4]).

The great majority of cases originate in articular affections. Indeed most of the deeper articular processes lead to contractures or ankylosis of the joint. The process is usually this—after destruction or perforation of the articular cartilage, the granulations on the surface of the two extremities become adherent, and during recovery firm fibrous adhesions are gradually formed, which later may become ossified. Or else, as the result of inflammatory irritation, spicula of bone,

stalactite-like osseous proliferations develop and interfere with motion, or lead to complete adhesion (Fig. 156). The most various articular affections, especially of tuberculous, rheumatic, but also of gouty, gonorrheal, syphilitic, puerperal, neurotic, etc., nature, may thus lead to ankylosis; and many of these articular affections have a particularly marked tendency to cause multiple ankyloses, especially the gonorrheal and rheumatic. Inflammatory processes, traumata, etc., in the neighborhood of the joint, may also give rise to ankylosis. Phlegmons, phlegmonous erysipelas which causes extensive

Fig. 156.—Ankylosis of the Knee with Subluxation (Seen from Behind).

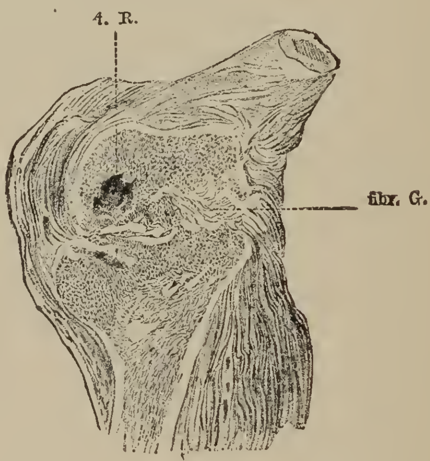


Fig. 157.—Fibrous Ankylosis of the Knee with Tuberculous Remnant in the Condyle of the Femur. (Onix.)

necrosis of cellular tissue, burns, etc., followed by considerable cicatricial contraction, cicatricial contractures, fractures, etc., near the joint are of particular importance as causal factors. Morbid processes in the muscles, *e.g.*, so-called *myositis ossificans,* may cause extensive ankyloses.

In the majority of cases these etiological factors are combined, *e.g.*, in the finger contracture occurring frequently in consequence of gangrenous forms of panaritium, the loss of the flexor tendon and cicatricial contractions and adhesions around the joint playing a part in the abnormal position.

The pathological anatomy of ankyloses allows the differentiation into ankylosis spuria (fibrosa, cartilaginea, ossea),

also into synostosis and ankylosis extracapsularis (bony-bridge ankylosis). Usually the real osseous adhesion is preceded by a stage of fibrous or cartilaginous ankylosis, and the pathological conditions found vary according to the stage or duration of the affection.

Chronic ankyloses may lead to adhesions so uniformly firm that it is hardly possible to recognize any demarcation of the bones, either on the external surface or in the internal structure; frequently, where the inflammatory process is still present, the synostotic bones are covered with numerous stalactitic fine bony needles, etc., which are inclosed in a more or less firm cicatricial mass (Fig. 156).

An important fact is, that in ankylosed joints morbid deposits are often included, *e.g.*, tuberculous foci, which in case of trauma, etc., may cause a relapse or a fresh eruption of the disease. As a rule, the form of the joint is much altered, and cases are rare in which the affected bones appear only as if connected by bony substance, and otherwise unchanged.

The muscles which are thrown out of action by the ankylosis are usually more or less atrophic, in chronic total ankyloses they are often fatty degenerated throughout; the growth of the affected limb is more or less markedly stunted, according as the morbid process has occurred early in life, and has implicated the epiphyses or not.

The symptoms of ankylosis consist in the greater or less loss of mobility, occasional major or minor deformity, and further in secondary or compensatory disturbances.

A positive diagnosis of the condition can only be made in narcosis, since involuntary contractions of the muscles, etc., may simulate contracture or ankylosis. Anæsthesia will also permit the recognition of the kind of ankylosis; for instance, if in case of bony ankylosis one hand is placed above, another beneath the affected part, a peculiar sensation of rigidity is imparted when passive movements are attempted. Immobility alone is by no means a sign of bony ankylosis. In examining without anæsthesia, it is to be noted that gentle manipulations (the patient's attention being diverted) facilitate the diagnosis, since forcible movements readily cause reflex contractures.

Sanson[5] relates a case in which a hospital physician had diagnosticated ankylosis of the hip of a child; but another

physician present, by directing the child's attention to some other subject, easily demonstrated the mobility of the joint.

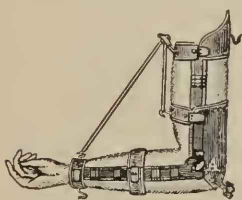
At the present time, the prognosis of ankyloses and contractures is generally favorable, for it is possible in most cases to cure the condition by apparatus, massage, manipulations, etc., and if necessary by operative methods (which have become justified only since the advent of antisepsis), or at least to give the limb a position most useful to its function.

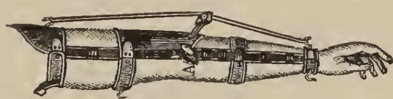
In the way of treatment, mention should first be made of prophylaxis, which consists in the correct treatment of the rather frequent joint affections, fractures, etc., that is to say, the diseased joint should always be fixed in its most useful position (*e.g.*, elbow flexed, knee and hip extended). In general, the fixation should not be continued too long, but be supplemented at the proper time by massage, manipulations, frictions, passive and active movements, etc. Where cicatricial contraction is anticipated, this should be counteracted by appropriate position.

The treatment aims at stretching the contracted parts, at making the ankylosed joints movable, or at least as useful as possible functionally.

The milder measures, gradual (elastic) traction, massage, etc., can be successfully employed only when the adhesions are not too firm. The great number of ingenious appliances devised for the treatment of contractures and ankyloses consists usually of two excavated splints for receiving the respective parts of the limb, made adjustable at the desired angle by screws, etc. Where it is necessary to change an angular position into a straight one, the commonest methods are simple extension by weights, according to Volkmann, or elastic traction appliances. Where mobility is aimed at, the splints are made movable on each other by a cord running over a pulley, on a higher level, as in Bonnet's automobile apparatus. Elastic traction may also be used for this purpose by being made to act alternately in the direction of flexion and extension. Reibmayr and others have devised such apparatus. Figs. 158 and 159 show a simple apparatus for restoring mobility to the elbow joint (a hinge joint is inserted at A). Since, however, these methods are slow in action and without effect on the firmer adhesions, it was but natural that efforts were early made to break up the ankylosis forcibly, or to

overcome an abnormal angular position. It is mainly since the time of Louvier, who performed forcible redressement with a machine of his own invention, that we can speak of a separate method of "redressement brusque" or "brisement forcé" (arthroclasm), *i.e.*, a rapid, forced correction of the position —a procedure perfected chiefly by Dieffenbach, Langenbeck, Palasciano, and others. *Brisement forcé,* however (with which, by the way, Louvier did a good deal of mischief, as shown by some autopsies), only found general acceptance after the introduction of anæsthesia. As a rule, the manual power of the surgeon suffices, but the osteoclasts which we have already described (Collin, Robin, Beely, etc.) may likewise be used. The aim is to start the movement in accordance with the normal axis of the joint, so as to avoid infractions or fractures. It is particularly important that the force should not act too far





FIGS. 158 and 159.—Apparatus for Correcting Contracture of the Elbow by Alternate Elastic Traction. (After Collin.)

along the long lever arm of the peripheral portion of the limb, and it is advisable in some cases where great force is to be exercised to cover the limb with a plaster dressing up to the point where mobility is to be established, and by including a long splint in the dressing, to use the latter as the prolongation of the lever arm.

The first attempts at forced movement should always be made in the sense of flexion, only the later ones being toward extension, afterward flexion and extension may be combined.

It was formerly believed that the tense sinews and fasciæ should almost invariably be first divided (Brodhurst, etc.), but this preliminary tenotomy can be avoided as a rule, and where it becomes necessary it is, of course, to be done under antiseptic precautions. If the bone is connected with adherent cicatrices, their subcutaneous detachment may be indicated, so as to avoid rupture of the skin in the redressing; in

the case of cicatricial contractures, division or excision of cicatrices must occasionally be performed.

Brisement forcé is performed in profound narcosis; the limb is properly fixed by the hands of the assistant, the surgeon grasps the peripheral portion with both hands, forcibly flexes and then extends the limb, continuing the alternate attempts at flexion and extension until good mobility in both directions is attained. After this a suitable dressing is of great importance. Sayre recommends bandaging the limb, commencing at the peripheral end, and exerting compression over the joint by sponge (a cotton pad, etc.). The limb is kept elevated and the bandage is changed only after six or seven days. When the adhesions are extensive, a distinct crackling can generally be heard during *brisement forcé*, and all of a sudden the joint gives way; with proper precautions the method is free from any great risk. The method is, of course, out of the question, while inflammation or suppuration is still present. We must remember, above all, the possibility of setting up acute suppuration (Oberst [6]) or the occurrence of general tuberculosis from *brisement forcé* (Szumann [7]), and latterly, indeed, the method has been employed less frequently than it was by Langenbeck.

Even complete bony ankyloses in unfavorable position are of favorable prognosis to-day, for the antiseptic treatment of wounds justifies us in performing various operations on the bones—operative correction. A combined method is that where ankylosed bones, like the patella or the olecranon, are detached with the chisel (Maunder [8]) before performing *brisement forcé* or where the soft parts are first divided (avoiding vessels and nerves). For true ankyloses in unfavorable position the operations to be mainly considered are osteotomy (simple linear, arciform, etc.), osteectomy, more rarely *resection en bloc, i.e.*, removal of the adherent articular surfaces.

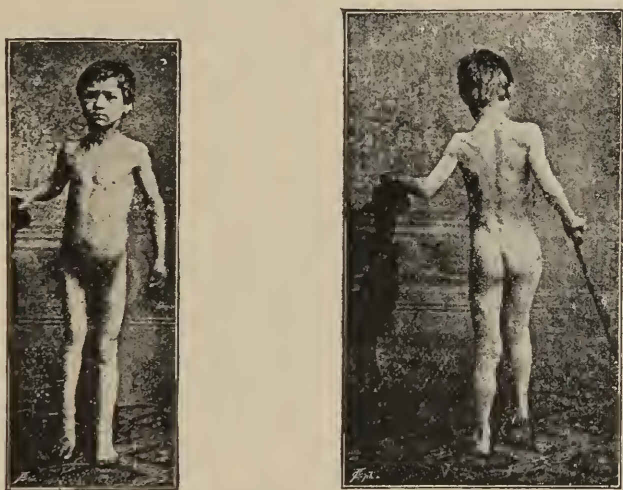
In case of angular ankylosis of the knee, Bauer used to resort to amputation; but, to-day, such radical means will be called for rarely, except in case of ankylosis of the fingers which interferes with working or where the fingers are no longer functionally useful owing to considerable degeneration, stunted growth, etc.

To pass, now, to the consideration of the contractures and of ankylosis of the special joints, the larger articulations of

the trunk and those of the hand are practically of the greatest interest.

Contractures or ankyloses of the hip-joint are probably very rarely of a cicatricial nature, and are more frequently due to peri-articular inflammations, such as that following on psoas abscesses, etc. The great majority of cases of true ankyloses are arthrogenous, *i.e.*, arise in connection with coxitis, and result in flexion, adduction, and inward rotation of the limb.

The characteristic position of the leg, which is usually asso-



Figs. 160 and 161.—Deformity after Coxitis. The Affected Extremity is Stunted in Growth and Nutrition.

ciated with muscular atrophy and shortening, causes essential disturbances in walking, such as limping, and the greater the flexion the more pronounced will be the secondary lumbar lordosis and the depression of the pelvis, the result of efforts to use the leg in walking. Secondary kyphotic compensatory curvatures and static skoliosis may be ultimate sequelæ; the disturbances are of course greater in bilateral ankylosis.[9]

The disturbances are the greatest in the rarer forms of ankylosis of the hip in flexion and abduction, where even crutches cannot be used. The most aggravated of all is bilateral ankylosis in abduction, of which I have seen several

examples (Fig. 162), where the patients are forced to move on all fours or to jump like frogs.[10]

Such deplorable deformities occur especially after severe articular rheumatism, and they may not be recognized for a long while, owing to the fact that the patient is bedridden.

Prophylaxis of contractures of the hips, etc., consists in the correct treatment of hip-joint disease by extension and fixation (Thomas, Taylor, Bryant, Sayre's splints, etc.), and in appropriate resort to passive movements after acute rheumatism, etc.

In examining for contracture of the hip, care must be taken that the pelvis is straight, and that the lumbar spine rests on the couch, for even in flexion-contracture of the hip the thigh

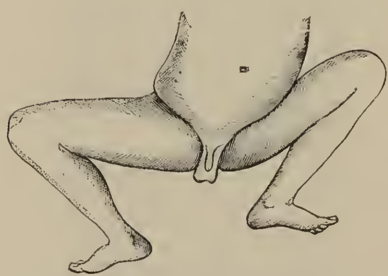


Fig. 162.—Bilateral Contracture in Abduction following on Rheumatism, etc.

Fig. 163.—Flexion Contracture of the Left Hip-joint.

Fig. 164—Apparent Equalization by Lordosis of the Lumbar Spine.

can be pressed down on the bed (Fig 164), since the lumbar spine assumes a compensatory curvature, and the hand may be passed under the sacrum of the patient. If the lordosis is straightened so that the entire spine rests on the couch, the thigh in flexion-contracture points upward.

In order to test the degree of mobility, an assistant must firmly fix the pelvis of the anæsthetized patient, while the surgeon manipulates the leg. In contractures permitting some motion, the ordinary extension dressings may suffice, provided the pelvis is properly fixed.

Lorinser [11] deems it better to fasten the thigh and to make the two tuberosities of the ischium points of fixation, gradually raising them by a screw, while the weight of the trunk effects a slow depression of the lumbar spine. (See Fig. 165, in which *b* represents the pelvic bolster which is raised by the

screw S, between the two segments of the mattress; while Fig. 166 shows conjoined extension of the leg by the screw S.)

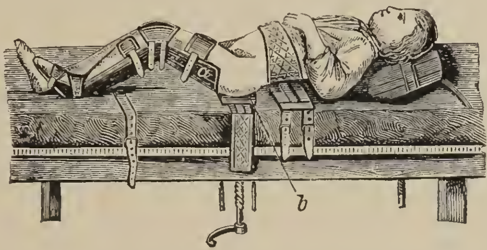


Fig. 165.—Lorinser's Apparatus for Contracture of the Hip.

The various forms of extension beds (Heine, H. Bigg, etc.), may also prove useful in the graver cases.

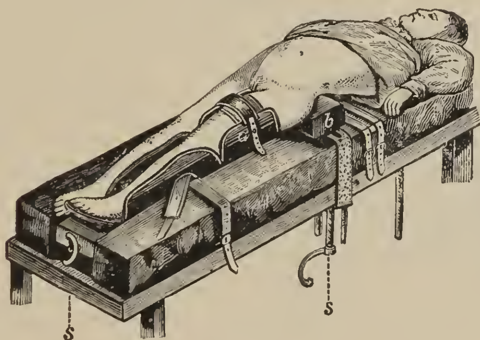


Fig. 166.

A number of special apparatus have also been devised for contracture of the hip. One of the simplest methods, which

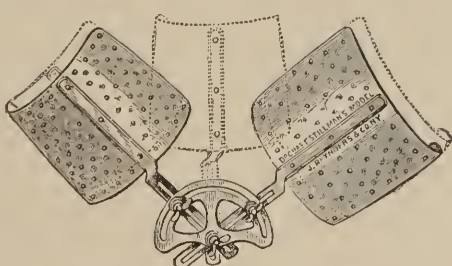


Fig. 167.—Stillman's Sector Splint.

may be conjoined with extension, is that by Stillman's sector splint (Fig. 167), which is applied in a plaster dressing, sur-

rounding the pelvis and thigh, and it permits changes of position only in the sagittal plane. Another apparatus of Stillman's aims at mobility in all the three planes through a universal joint.

Of other apparatus for ambulatory treatment in redressible contractures of the hip, mention may be made of that of H. Bigg, the mechanism of which is based on an S-shaped spring, or of another devised by the same gentleman, in which elastic traction is applied from behind to the thigh splint by a lever arm, the endeavor being to extend the thigh, while the pelvis and spine are supported by a belt and an axillary crutch, respectively. Berthet has devised an apparatus in which two angular lever arms (one springing from the pelvic belt, another from the thigh splint) are approximated by elastic traction.

Other apparatus (H. Bigg, Mathieu, etc.) utilize an endless screw at the hip-joint for overcoming the contracture.

In the extension apparatus devised by Ulrich and Mittler [12] motion is also effected by means of an endless screw, while fixation is secured by an iron band surrounding the pelvis, and by pads bearing on the symphysis and on the iliac spine. Perineal belts prevent displacement.

Where the object is not merely correction of the position, but mobilization of the hip-joint, use may be made of an apparatus recommended by Brodhurst [13] after H. Bigg, in which the pelvis is properly fixed, and a cord is attached to the lower extremity and carried over a pulley in the ceiling, so that the patient may practise passive flexion of the hip by traction on the cord, while the weight of the limb brings it back into extension.

Other ingenious appliances have been devised by Bonnet for passive movements, especially for rotation of the hip.

For the rare cases of adduction-contracture, successful use may be made of H. Bigg's instrument, which consists of two splints, connected by a hinge, passing along the inner surface of the thigh, with leather caps for the region of the knee. The splints may be set at any desired angle by means of screws and extension rods, while the point of the instrument rests below the perineum. A similar apparatus has been devised by Busch. The simplest instrument for keeping the knees apart is the spiral spring set between pads.

In cases where bony adhesion has not yet occurred, more rapid results may be reached with the method introduced chiefly by Berend, Dieffenbach, and Langenbeck, viz., forced redressement, a method which, of course, is contra-indicated when the disease has not yet run its course, or fistulæ, etc., are present. Usually we hereby only secure improved position, and even this by several repeated attempts, rather than at a single sitting.

Ordinarily manual force will suffice, but we must beware of causing a fracture of the diaphysis of the femur—an accident which has occasionally occurred. Fracture of the neck of the femur (as has been observed by Rossander, Tillaux, and Volk-

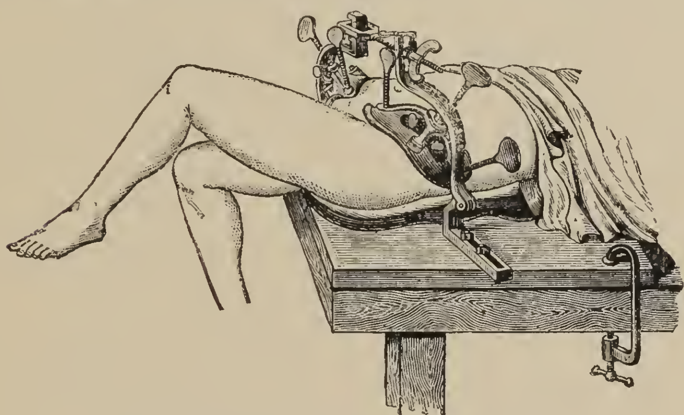


FIG. 168.—Terrillon's Apparatus for Fixation of the Pelvis.

mann [14]) is no great disadvantage, since the thigh may afterward be extended.

Special fixation apparatus has been recommended for *brisement forcé* of the hip. Bauer's apparatus consists of a wooden block, padded with leather, which is closely fitted and strapped to the posterior surface of the pelvis. The apparatus of Collin-Terrillon is easily understood from Fig. 168. For instrumental *brisement forcé* the apparatus of Robin, Collin, and others, previously described, may be used.

When the limb has been straightened, much depends, of course, on the correct maintenance of the improved position, and to this end traction dressings, Bonnet's wire hose, etc., must be used for several weeks at least.

In a large number of cases, especially of osseous adhesion, operative methods must be considered. Many operators favor tenotomy followed by *brisement forcé* (Sayre).

For bony ankylosis of the hip in angular position, operation under antiseptic precautions is certainly a safer method than forcible manual or instrumental osteoclasis.

Rhea Barton, in 1826, was the first to divide the femur between the trochanters with the fret-saw, in bony ankylosis of the hip, and since then oteotomy had been further developed. Langenbeck first perforated with an auger, and then divided the bone from this point as far as the cortical layer, when the fracture was completed. Adams (1869) performed subcutaneous osteotomy of the neck of the femur with the saw, but with careful antisepsis it is certainly preferable (MacEwen) to make the wound large enough for the introduction of the finger, and then to divide the neck of the femur with the chisel, when the thigh can be easily straightened and healing ensues under the first dressing. Brodhurst pointed out that it was of great importance to effect the division as near as possible to the centre of motion.

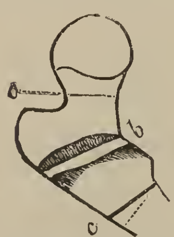


FIG. 169.—*a*, Osteotomy of the Neck of the Femur; *b*, Intertrochanteric Osteotomy; *c*, Subtrochanteric Osteotomy.

In many cases it is better, owing to destruction of the head of the femur, or to osteophytic proliferation around the neck, etc., to make the division below the trochanter according to Gant[15] and to Maunder. Subtrochanteric osteotomy has been chiefly developed by Volkmann,[16] so that at present it represents the most frequently employed procedure, and is especially adapted to serious adduction-contractures in which the head of the femur is outside the acetabulum and *brisement forcé* is therefore inapplicable.

The division is effected with the chisel about opposite the small trochanter (Volkmann), after detachment of the periosteum; a wedge-shaped piece is excised, whose base, corresponding to the conjoined position of flexion and adduction, is directed backward and outward; the bone is not cut through entirely, but the wall at the minor trochanter is fractured, as the last step.

Holmer and others carry the osteotomy somewhat deeper

than Volkmann. What serious deformities may be rectified by these operations is shown among others by G. Ledderhose's [17] case of bilateral subtrochanteric osteotomy for ankylosis of both hips, in extremely adducted and inward rotated position, in a man aged twenty, represented in Figs. 170 a and b before and after operation respectively. Next in order are the wedge-shaped osteotomies for ankylosis of the hip, which were also largely practised by Volkmann, K. Rodgers, and Sayre.

Although after various osteotomies of the neck of the femur, mobility has been attained (Brodhurst, Adams), the

FIG. 170 a.—Ankylosis of both Hip-joints in Curved Position.

FIG. 170 b.—The Same after Operation (Ledderhose).

majority of operations aimed only at improvement of position; and in order to secure mobility after osteotomy, Sayre [18] has only excised a semilunar piece from the neck of the femur, the concavity being directed downward, and in such cases he has attained his object of imitating the natural joint and of making it movable.

Where we have reason to believe that morbid residues are present in the hip-joint, *i.e.*, where the inflammatory process has not run its course, it would appear preferable to remove the remains of the head and neck of the femur, by making Langenbeck's usual posterior longitudinal incision and separating the great trochanter with a chisel. After that the acetabulum should always be exposed and inspected (Kölliker [19]). In rare cases, *e.g.*, in strongly abducted position, an

anterior longitudinal incision is more suitable (as performed by Billroth and others). The after-treatment of orthopedic resection of the hip is the usual one, extension by weights for from three to six weeks, after which the patients practise walking with Volkmann's stool (*Gehbänkchen*), while extension is continued during the night for a longer time (Kölliker), and then follow active and passive gymnastics by methodical movements, etc. The cure of angular ankyloses, together with retention of mobility of the thigh, has thus been secured after resection with the chisel (Gritti).

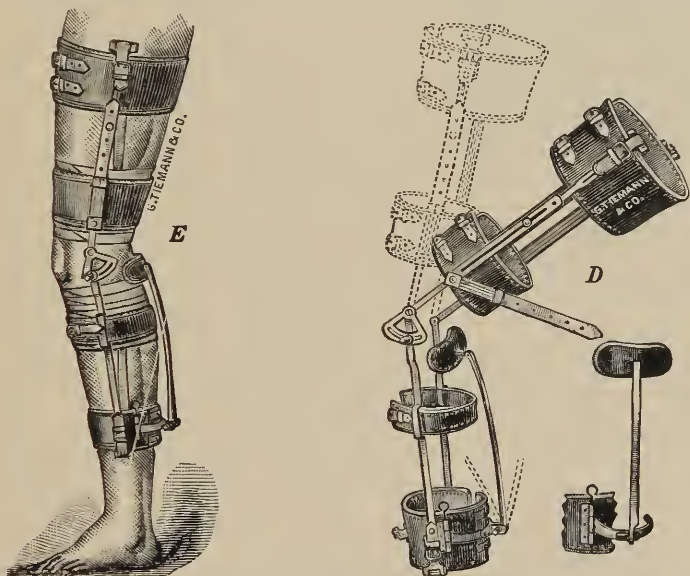
Rosmanit[20] has calculated the following mortality: after 35 osteotomies at the neck of the femur, 11.43%; after 34 subtrochanteric osteotomies, 8.82%; and after 28 wedge-shaped excisions below the trochanter, 7.14%. Hence there is no material difference in the statistics and the same may be said of the functional results; resection, being a more formidable operation, has a greater mortality, 30% (Rosmanit), which will, however, be reduced by antisepsis.

Resection is absolutely indicated only in bilateral ankylosis, since two stiff legs cannot be used for walking, especially since not even crutches can be employed in the abducted position. On one side simple osteotomy with correction of the false position may be done; on the other side, resection must be performed. Such double operations have been done by v. Bruns, Volkmann,[21] Billroth, Mordhorst, and others. Studensky[22] performed double resection and he obtained mobility on both sides in the new-formed joints, although, of course, the length of the legs became unequal, owing to the upper end of the femur on the right side gradually gliding up on the venter of the ilium.

The most frequent and important contractures are those of the knee-joint, which too often result from the faulty treatment of articular inflammation; according to their severity they represent a permanent grave injury which can be avoided by appropriate prophylactic treatment.

While in Germany retentive dressings in extended position stand foremost in the treatment of the usual fungous (tubercular) form of inflammation of the knee-joint, the only mistake being that these dressings are removed too early and contractures develop subsequently, in England and America special apparatus is in favor, which permits extension and

fixation in the desired position and can be worn through all the stages of the articular inflammation. Of these, mention will be made only of the apparatus shown in Figs. 171 and 172, after Stillman. In addition to the sector joint, it carries a pad which crowds the head of the tibia forward, thus counteracting the characteristic subluxation of the tibia. Ankyloses of the knee-joint in extended position will seldom come under treatment. Angular contracture or ankylosis of the knee, being a very frequent deformity, probably usually requires



Figs. 171 and 172.—Apparatus for Inflammation of the Knee-joint. (After Chas. Stillman.)

surgical treatment, although, under the methods of treatment now generally employed in chronic inflammations of the knee-joint, it is exceptional that we see cripples who ride, so to speak, with the thigh on a wooden leg, the angular stiff knee projecting in front.

For straightening angular contractures of the knee and fibrous ankyloses, use is made in mild cases of gradual extension (with oblique foot-board, extension by weights downward at the knee, elastic traction, etc.); in most cases we must rest content with stretching the leg and thus enabling the patient to walk.

Wiskemann[23] effects the stretching by fastening to the extensor side of the thigh a long splint which is nailed to an upright board at the lower end of the bed, whereby he attains a sort of suspension of the leg, and (with appropriate fixation of the pelvis) the leg is gradually approximated to the splint, or stretched by elastic bandages. If the pain is great, the elastic traction may be intermittent.

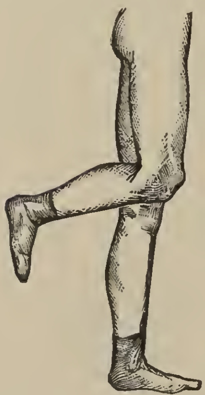


FIG. 173.—Angular Ankylosis of the Knee. (After Lorinser.)

Elastic traction may also be applied by fastening to two articulating splints elastic cords, running over pulleys affixed higher up, as, for instance, in the apparatus devised by Schepelern.

Another very suitable apparatus is that of Lorinser[24] (Fig. 174), which consists essentially of three small boards adjustable to each other (2, 3, 5); of these the leg board, which is joined to the thigh board by a hinge, carries at its lower end a movable nut (6), through which passes the horizontal screw of the base board, which is turned with a key (Fig. 174). The apparatus of Tamplin and Duval belong in the same category.

Bonnet's well-known apparatus is very similar. It consists of two hollow splints joined by a hinge in the region of the knee, and a base board. The foot is surrounded by a sort of leather gaiter, to which is fastened an extension cord, to be tightened by a spindle. Two small pulleys at the foot end of

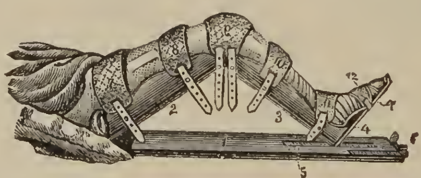


FIG. 174.—Knee Extension Apparatus. (After Lorinser.)

the leg splint prevent friction as much as possible. Volkmann recommends the apparatus in the form of two well-fitting tin splints joined by hinges and fastened to a base board, using weights as the extending force. For the gradual ambulatory extension of contracted knee-joints a large number of apparatus has been devised. Among the simplest are the retentive

dressings which are applied after the best feasible correction of the position (under anæsthesia) has been attained and are renewed at suitable intervals after further correction.

Since it is desirable to keep the joint under observation during this time, frequent use has been made particularly of interrupted retentive dressings, with articulated splints adjustable at the side.

Fig. 175.—Sector Splint.

A very suitable form is the sector splint, such as that recommended by Braatz,[25] in which the leg splint can be set at any desired angle in a sector groove of the thigh splint, so that the position can be improved manually every few days, and be retained by a thumb screw; or the form advocated by Stillman [26] under the name of "sector joint brackets and splints" which can be set at any angle without being removed, permits extension and occasionally motion, and is usually fastened by means of a plaster-of-Paris or adhesive plaster dressing.

These sector splints are made of steel with a flexible, perforated copper plate for encasing the limb, a sector (Fig. 175) being interposed at the joint. A slit in the sector permits motion to any desired angle, where the thumb screw will retain it.

Fig. 176.—Stillman's Sector Splint.

A large number of the apparatuses devised for angular contracture of the knee, are based on the application to the side of the angle of an extensible screw-worm, by which the angular position can be gradually diminished (Kolbe, Pancoast, Roberts,[27] Salt, Burow, Nyrop).

One of the best known of these is Eulenburg's extension apparatus, consisting of two articulating capsules, in which the leg and thigh are fastened by straps; by means of endless screws, a spindle and a winch, they may be moved on each other as described.

The apparatus permits the patient himself to make exten-

sion and flexion movements, and is distinguished by facility of application, uniformity and, as desired, either slowness or rapidity of effect.

According to Bidder,[28] the apparatus has the advantage that (since buckles and straps are not used) any circular constriction is avoided. Two semicircular grooves for the calf and anterior surface of the thigh form the main points of support, to which are applied the curved steel splints which articulate in a joint with endless screw lying anterior to the axis of rotation of the knee. The "saddle-groove" fitted to the posterior surface of the thigh, which adapts itself to the movements and is to be fastened with straps, prevents separation of the upper portion of the thigh splint when the screw is tightened.

Ridlon [29] in his apparatus employs a hinge-joint adjustable

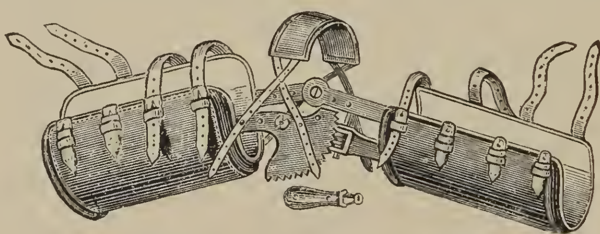


Fig. 177.—Dieffenbach's Apparatus for Extension of the Knee.

by an endless screw. Thigh and leg are bandaged to the dorsal padded steel hollow splints.

Dieffenbach's contrivance, which is warmly recommended by V. v. Bruns, consists of grooved thigh and leg splints with two lateral splints (connected by cross pieces) articulating at the knee. The outer thigh splint ends in a semicircular plate toothed at its convex margin, the cogs being geared into the grooves of an endless screw at the upper end of the leg splint, so that the leg piece (which, like the thigh piece, is fastened with several straps) can be set by means of a key at any desired angle to the other. A square knee cap, applied in front over the patella and the condyles of the femur and buttoned to the splints, serves for further fixation, and prevents forward deviation of the knee.

The apparatus devised by Langgaard [30] (likewise provided with bilateral splints, laced thigh and leg pieces, and anterior

knee cap) is moved by an endless screw on each side of the upper end of the leg splint, where it engages in a toothed wheel at the lower end of the thigh splint. In the form de-

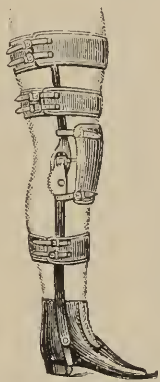


Fig. 178.—Stromeyer's Apparatus for Extension of the Knee

Fig. 179.—Erichsen's Apparatus.

vised by Stromeyer (Fig. 178), the toothed wheel is at the upper end of the leg splint, and the endless screw at the lower end of the thigh splint.

Of great value for slighter cases is the ingenious apparatus of Erichsen, or that of Heather Bigg, which is based on the action of two S-springs acting in opposite directions and, by

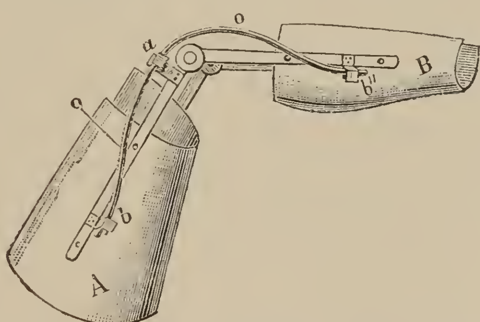


Fig. 180.—Oehler's Knee Apparatus with Spring Action.

means of two leather casings, it draws the leg forward, the femur backward, thus counteracting flexion and subluxation.

Other apparatus similarly employ spring power, as that constructed by Oehler[31] (Fig. 180), in which the laced leather

pieces are attached to two lateral articulated splints, each of which carries three small forks (one median, open in front, close to the joint; one above and one below, open behind). Into these forks springs are inserted (from one to six on each side, according to requirements) which give the leg a gentle, steady impulse toward extension.

Fig. 181.—Apparatus for Slight Angular Contracture of the Knee. (After Nyrop.)

Uniform, powerful traction can also be effected by the employment of rubber, which acts even more vigorously. Blanc,[32] of Lyons, has devised several appliances, all on the same principle, viz., jointed splints for thigh and leg (fastened by retention dressings or straps) are provided with anterior iron lever arms, which are approximated by rubber rings, thus aiming at the obliteration of the angle. H. Bigg applies to the thigh- and leg-pieces anterior iron hooks united by elastic traction; so does Nyrop (Fig. 181); two leg splints, hinged at the knee, united above by a pelvic strap, *e*, carry below a joint for the ankle, and a strap, *f*, for fixing the foot; above and below the knee are projecting lever arms for applying elastic traction, *b;* a knee cap, *c*, presses against the prominent knee. Such apparatus can be easily improvised with strong wire and an interrupted plaster-of-Paris dressing.

Reibmayr applies the elastic traction for extension of the knee-joint, by making the rubber cord act on the lower end of two iron rods fastened at their upper extremities to a band surrounding the femur. Quaas' mode of application is shown in Fig. 182; the leg being drawn by elastic traction toward a prolongation of the thigh splints. In many cases, after removal of the contracture, it is necessary to wear for some time an appropriate protector, *e.g.*, like that of Lorinser shown in Fig. 183, in which 1 represents the lateral steel splint; 2, the clasp for the thigh; 3, that for the leg; 4, the thigh band; 5, the knee band; 6, the leg band. In many cases of contracture and fibrous ankylosis, in which the presence of residuary morbid foci may be excluded, *brisement forcé* succeeded by fixation in improved position, may be expected to

yield the most rapid results; but it is important to avoid the danger of infraction of the tibia, in other words, the long lever arm (the leg) must not be made to bear too great a strain.

Redressement forcé at the knee is performed in the following manner:

The patient lies on the abdomen, the anterior surface of the thigh resting on the table so that the lower end of the femur occupies the edge of the table, and the flexed leg projects free into the air; the latter is grasped by the right hand of the surgeon immediately below the popliteal space, and pressed

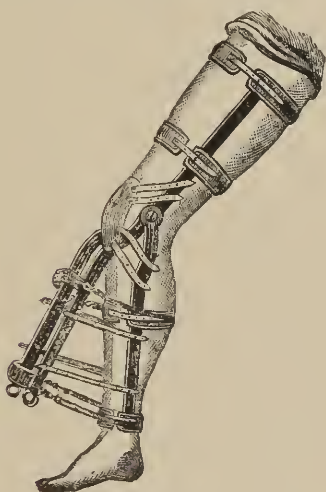


Fig. 182.—Quaas' Apparatus for Extension of Contracture of the Knee.

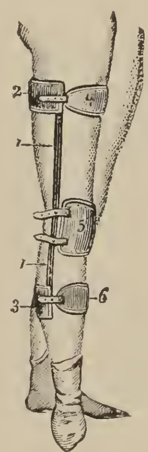


Fig. 183.—Apparatus for Fixation of the Knee. (After Lorinser.)

forward, while the left hand bears down on the thigh. In this way we dispense with the long leverage of the leg, but can easily augment the force by throwing the weight of the trunk on the hand, until the leg yields to the pressure and the extension can be completed, when it is fixed in a plaster-of-Paris dressing or secured by an appropriate protective apparatus (Fig. 183).

In angular osseous ankyloses or those in which the morbid process has not quite run its course, operative measures may be indicated.

Where the patella alone is adherent, it may be sufficient to free it, either according to Hüter with a simple wedge of wood

without injuring the skin, subcutaneously as it were; or else, according to Maunder,[33] with a tenotome inserted at the edge of the patella.

In bony angular anykloses, osteoclasis of the lower portion of the femur has been repeatedly performed (Ollier, Perrusset). Pousson collected fourteen cases. Surgical methods will, however, still be required for a portion of the cases. The first to be considered is linear or arciform (Rosmanit) osteotomy of the tibia or femur or both for acute-angled ankyloses, where mor-

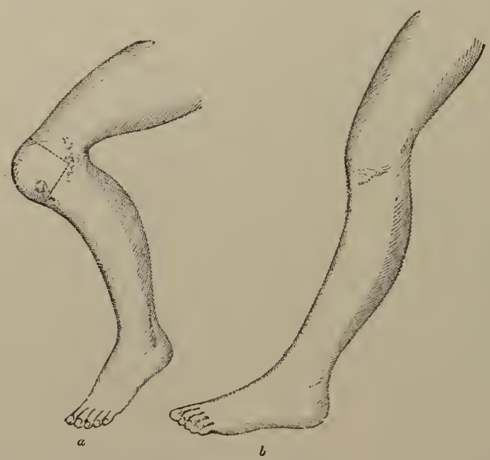


FIG. 184.—Wedge-shaped Excision in Right-angled Ankylosis in the Knee; *a*, before; *b*, after Operation.

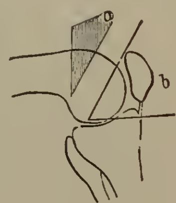


FIG. 185.—Schematic Representation of Excisions in Angular Ankylosis of the Knee.

bid foci are no longer present, and the process has terminated in bony ankylosis.

Volkmann performed the first antiseptic osteotomy of the femur for ankylosis of the knee in 1874, then followed Billroth, MacEwen, etc.

The first rank is to be accorded to wedge-shaped osteotomy, as performed originally by Rhea Barton, that is to say, it is necessary to remove a wedge of bone from the lower end of the femur, which usually projects forward, so as to effect straightening; the shaded part *a* in Fig. 185 represents this method schematically.

Next to be considered is *resection en bloc* (Gurdon-Buck), *i.e.*, the resection of the bony adherent joint (*b*, Fig. 185) for cases in which prolongation of the affected bone is associated

with angular fixation. The size of the bony wedges which must here be occasionally removed appears from Figs. 184 *a* and *b*, which represent the extremity of a young man of twenty, before and after *resection en bloc*.[34]

The gait of the patient in this case was all the more objectionable because, besides the right-angled complete bony ankylosis, the affected femur had elongated in consequence of the long-standing articular disease; the function of the straightened leg has become quite satisfactory.

Much more frequent are the orthopedic resections of the knee-joint in angular ankylosis with incomplete bony adhesion which has not quite run its course; resections which, in children, should be performed as conservatively as possible. The operation is best begun with a curved incision below the patella; the condyles of the femur are first removed with the curved saw, after a flap containing the patella has been turned upward. Frequently it becomes necessary, in order to avoid a sharp edge, to remove an additional piece of bone obliquely upward from the posterior portion of the sawn surface (Kölliker); if the leg can then be easily straightened, the tibia must be freshened as superficially as possible, in order to attain bony ankylosis. If the patella lies well upon this, it is freshened and may contribute to the subsequent firmness of the joint; but if it is diseased or fits ill to the tibia and femur, it should be removed.

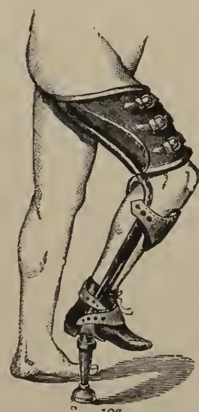


Fig. 186. — Supporting Apparatus for Angular Contracture of the Knee.

The bone and the ligamentum patellæ may also be sutured, as well as the capsule; then follow drainage, closure, and aseptic permanent dressing.

Owing to the good results from such operations and their safety, it will be exceptional that we will be compelled to order apparatus for patients with angular ankylosis and defective gait, such as the various appliances from the simple wooden leg with saddle to the more complicated apparatus, which answers no other purpose than to permit the patient to walk at least tolerably (Fig. 186).

The contractures of the ankle-joint will be discussed in the

following chapter on talipes. Complete ankylosis at the ankle-joint will furnish ground for operative interference only when it has occurred in a direction which disturbs the function, *e.g.*, pronounced equinus or calcaneus position. Osteotomy and wedge-shaped excisions are here also in place. For bony ankylosis at the tibio-tarsal joint with pes equinus, Berend [35] and Billroth performed wedge shaped excision from the tibia—a procedure which had been recommended by Velpeau.

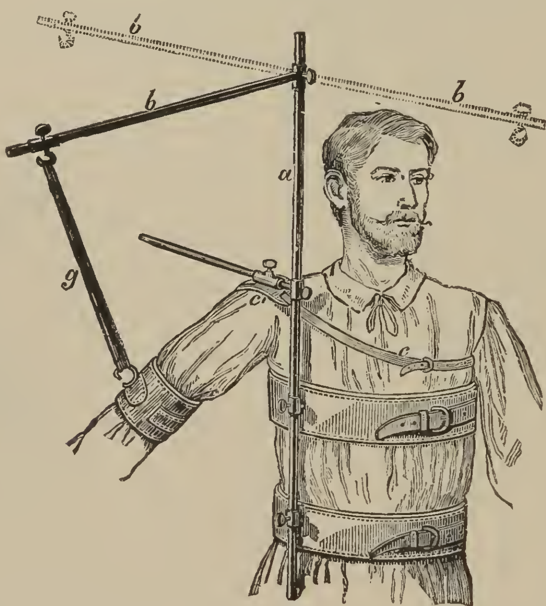


FIG. 187.—Reibmayr's Apparatus for Contractures of the Shoulder-joint.

The important ankyloses of the maxillary joint do not belong in orthopedics; concerning them, the reader is referred to the recent contributions of König, Ranke,[36] and Zipfel.[37]

Contractures and ankyloses at the shoulder-joint may remain as sequelæ of various forms of articular inflammation, disease of neighboring structures, etc. Here it is advisable to employ prophylactic fixation in different positions, and early manipulation and massage. Appropriate treatment is of especial importance in children, to avoid the occurrence of disturbances of growth in the affected region.

Reibmayr has devised an apparatus for the elastic stretch-

ing of ankyloses and contractures of the shoulder-joint which is shown in Fig. 187. The rod *b* is adjustable in three directions corresponding to the free excursions of the joint; *g* is the elastic strap which effects movement at the peripheral end, while counter-pressure is represented by the pad which is also adjustable at the main rod *a*.

In severe cases, *brisement* under anæsthesia and, where the muscles are in good condition, even resection may be requisite.

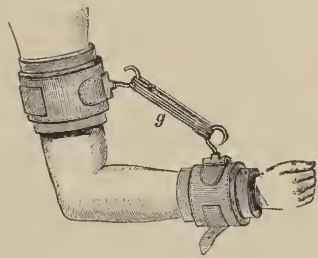


FIG. 188.—Flexion of the Elbow-joint.

Cicatricial contractures (especially after scalds) at the elbow require appropriate extension dressings, and occasionally operative interference (division of the cicatrix, plastic operations) which cannot be discussed in this place; even myogenous contractures, though rare, have been observed. At the elbow-joint, however, the arthrogenous contractures and ankyloses are by far the most important, and most frequently require special orthopedic treatment. The degree of contracture or ankylosis is easily recognized under anesthesia. The possibility of increasing the flexion differentiates contractures from ankyloses even without narcosis.

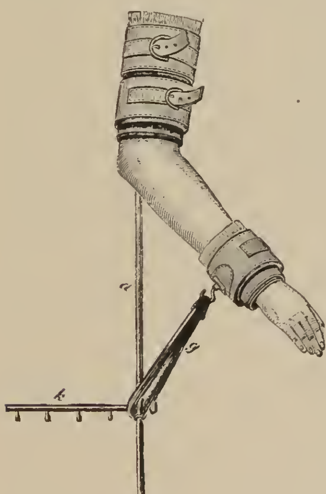


FIG. 189.—Extension of the Elbow-joint (Reibmayr).

In all cases of trauma, or diseases of the elbow-joint, passive movements should not be too long delayed. Where the latter alone are insufficient, Bonnet's apparatus for the mobilization of the elbow is a very suitable instrument for gymnastic manipulations and exercises.

Lücke's [38] apparatus with elastic traction (originally intended for use after resection of the elbow) is also of value, as are those of Reibmayr (Fig. 188) and Collin (Fig. 158), by means of which, according to requirement, flexed or extended position may be aimed at or interchanged; similar apparatus are those of Blanc and others.

Suitable apparatus may be constructed very readily by applying to the elbow an interrupted silicate of soda bandage with suitable hooks included, to which rubber cords may be fastened for flexion or extension.

Splint and clasp dressings, like Bidder's elbow splint, can easily be combined with elastic traction, and Vogt [39] justly calls attention to the fact that the hinge should always be applied above the elbow curve of the fore-arm splint.

Berthet effects flexion of the elbow-joint contractured in extension by affixing to fore-arm and upper arm, respectively, two lateral splints by means of circular clasps; they extend behind more than a hand's breadth beyond the elbow, hinges being applied at the joint and the ends being approximated by a rubber ring.

In order to counteract flexion-contracture of the elbow and to enable the patient himself to make passive motions in extension, v. Bruns [40] among others has devised a simple apparatus which consist essentially of hollow tin splints for the hand, fore-arm, and for the upper arm, respectively, joined by a hinge at the elbow and fastened to the extremity by bandages or clasps. At the lower side of the upper-arm groove extends an iron rod with a pulley at its anterior end, which projects beyond the groove for the fore-arm and which can be easily attached to a table by an angular hook with thumb screw. A cord passing from the lower end of the fore-arm splint over the pulley of the iron rod, manipulated by the hand of the sound side, effects extension, while flexion is performed by the flexor muscles or the elastic retraction.

A similar contrivance has been devised by J. Hoppe.

In a number of apparatuses for contracture of the elbow (Kolbe,[41] Stromeyer) the position can be altered by a screw thread applied on the flexor side, between the upper-arm and fore-arm splints; in others, like the apparatus of Parone [42] and Manget, the screw, by means of which the gutters joined by two articulating splints can be given any desired position, is applied laterally.

More complicated are the appliances of Goldschmid, H. Bigg, and others, in which the two lateral splints, articulating at the elbow-joint, can be given any desired position by a screw hinge, and the upper and fore-arm, fixed in padded concave metal sheaths, can thus be held at the necessary inclina-

tion to each other. Where the adhesions are very extensive, *brisement forcé*, followed by passive movements, will also yield the most rapid results at the elbow; where the contracture shows a tendency to recur, this can be counteracted by suitable splints with elastic traction.

Elbow-joints ankylosed in good position, *i.e.*, at about a right angle, will rarely call for operative interference; but in firm ankylosis in extended position resection is the best procedure for obtaining a movable joint; in bony ankylosis a wedge-shaped excision from the synostotic adherent joint surfaces will be requisite. Defontaine [43] obtained good results in one case by a trochleiform osteotomy.

Sayre performs the resection by making a simple straight incision over the joint, exposing the bone by drawing the soft parts aside, and, in order to reach the point of attachment of the triceps, separating first the end of the olecranon, then sawing through humerus, radius and ulna; then the extremity is placed in a fixation apparatus and passive movements are soon begun.

At the wrist-joint, as at the foot, various kinds of contractures occur which are termed club-hand (*main bot, Klumphand*); but while the lateral abduction and adduction contracture and the rotatory pronation and supination contractures are of but little practical importance, we are most interested in contractures of flexion and extension (dorsal and palmar club-hand).

Contractures at the hand are rarely congenital; in such an event they are usually combined with other abnormities (defective development of the bones of the fore-arm, webbed fingers, etc.). Congenital club-hand is ordinarily a contracture in the palmar direction, *i.e.*, an approximation of the volar surface to the flexor side of the fore-arm, at times with more or less pronounced lateral deviation.

The acquired contractures of the hand are much more frequent. They may result from injuries, especially burns, as cicatricial contractures which often give rise to the greatest deformities of the hand, *e.g.*, with fingers completely adherent to the dorsal surface of the fore-arm and fixed by cicatrices; or else, phlegmons, injuries to tendons may cause such deformities; or again they may occur as arthrogenous contractures in consequence of disease of the wrist-joint. The most fre-

quent of all the acquired contractures of the hand are probably the paralytic forms, *i.e.*, those occurring as sequelæ of

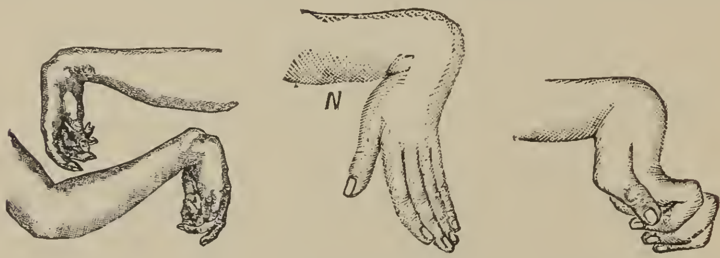


FIG. 190.—Congenital Club-hand. FIG. 191.—Traumatic Club-hand, Cicatrix at N. FIG. 192.—Pathological (Neurotic) Claw-hand.

infantile paralysis and other diseases of the central nervous system (Fig. 192).

Appropriate prophylactic treatment, fixation in a position opposed to the direction of the contracture, passive movements, and especially the application of elastic traction may here prove of considerable value. Reibmayr[44] among others has devised an ingenious apparatus for effecting alternate ex-

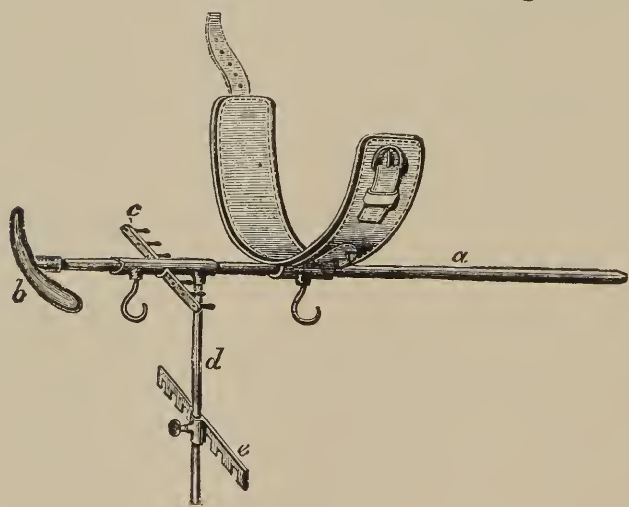


FIG. 193.

tension and flexion of the wrist-joint and the fingers. The apparatus (Fig. 193) consists of a well-padded leather bracelet, a longitudinal rod, *a*, with detachable frame, *b*, a rod, *d*, verti-

cal to a, and the two racks for affixing the rubber tubes (the latter the thickness of medium-sized drainage tubes, and tied at the ends into a loop). For the protection of the fingers,

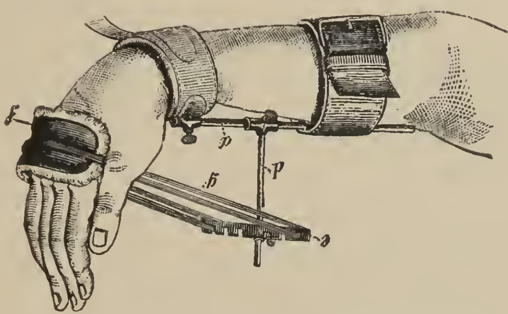


FIG. 194.—Reibmayr's Apparatus for Flexing the Wrist-joint.

i.e., to prevent the rubber tubes from cutting in, Reibmayr uses small tubes of sheet lead.

Figs. 194 and 195 show how the wrist-joint may be alternately extended and flexed. Similar apparatus can be easily improvised with interrupted retentive dressings, articulated splints, and included hooks or rods for the application of the elastic traction.

For flexion contracture of the hand, particularly, a number of appliances have been devised.

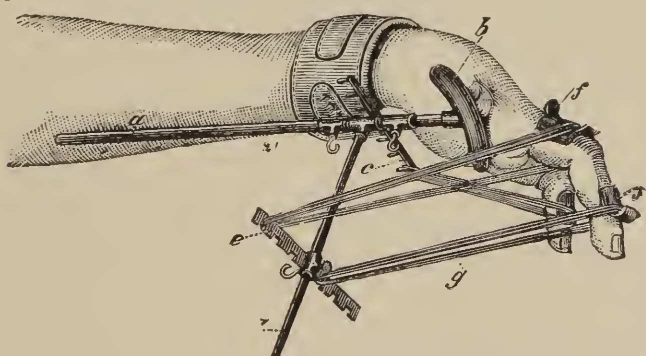


FIG. 195.—Reibmayr's Apparatus for Flexing the Fingers.

Blanc, for example, utilized the elasticity of a rubber ring for approximating the ends of lever splints, and bringing the hand into a straight position.

Gross' apparatus has a dorsal splint fastened to a sheath for the fore-arm which carries at its lower end, over the metacarpal joints, a transverse rod toward which the hand is drawn by an elastic cord, while a dorsal pad exerts pressure on the region of the wrist.

Bruns' apparatus consists of two gutter-like tin splints, joined by a hinge, for fixing the hand and fore-arm, together with an iron rod attached to the dorsal fore-arm splint, which projects beyond the wrist, toward which the hand is drawn by elastic cords.

In other apparatus, like that of Eulenburg and others, endless screws and toothed wheels constitute the adjustable mechanism of the parts which are held together by two lateral articulated splints and straps.

Similar apparatus, arranged inversely, has been constructed for dorsal contracture of the hand; for instance, by v. Bruns (who secured perfect cure by its means in a patient the dorsal surface of whose hand lay on the fore-arm, after he had first tenotomized the extensor tendons); it consists of gutters for the fore-arm, upper arm, and hand, united by hinges. From the volar surface of the hand-splint extends a steel arch which is fastened with a screw to a steel rod, provided with an anterior fissure and extending along the convex side of the fore-arm splint; this renders it possible to maintain the result obtained by manual reposition.

In congenital contractures of the hand, manipulations with fixation in the best possible position will quickly succeed. In the more extensive cicatricial contractures, the division of cicatricial bands, occasionally their extirpation, and transplantation of cutaneous flaps, may be necessary; tenotomy will rarely be required.

A wrist-joint ankylosed in good position does not call for operative interference; on the other hand, ankylosis in aggravated volar flexion may occasionally require resection and straightening, in order to improve the usefulness of the hand.

Finger contractures may also be the result of the most various traumatic or morbid disturbances. Prophylactic treatment will depend on proper management of the causal factors, on passive motion, etc.

Apparatus for finger contracture may be improvised very simply by adding suitable prolongations, such as iron rods

with notches, to a dorsal forearm splint. Against these rods the contracted finger is drawn by elastic cords. A further method consists in placing the hand on a board with processes for the several fingers, padding the contracted finger where it rests on the board, and gradually stretching it by an elastic cord (rubber band) passing over the vertex of the curvature.

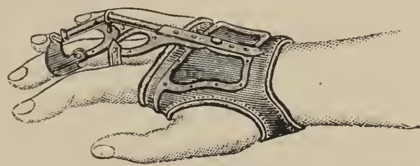


Fig. 196.—Collin's Apparatus for Finger Contracture.

Appliances suitable for the treatment of flexion contracture of the fingers have been devised by Bigg, Goldschmidt and others, in which dorsal splints adapted to the several fingers are movable by endless screws at the level of the articulations; the phalanges are fastened by elastic silk bands to the splints, which are in turn adjustable on a padded plate surrounding the metacarpus; or they may be made movable on the dorsal side of a padded tin splint for the fore-arm and hand (Goldschmidt).

Schönborn's apparatus for extending contracted fingers consists of a deerskin glove, made to button at the ulnar border, which extends above the wrist; into its dorsal part is inserted a steel splint (ten inches long) which, broad at first, narrows at the wrist, again widens at the metacarpus, and at the contracted finger again narrows into a gutter shape, and surrounds two-thirds of the first phalanx. To this gutter a second covered with leather is joined by a hinge, and it receives the volar surface of the second and third phalanges. It carries two wire frames, the peripheral one being one and one half inches high, the central one three-quarters of an inch. To the peripheral frame is fastened an elastic band which runs over a friction roller on the horizontal portion of the central frame, and is buttoned to a knob on the dorsal splint. Thus the traction acting on the finger depends on the thickness of the band and degree of its tension.

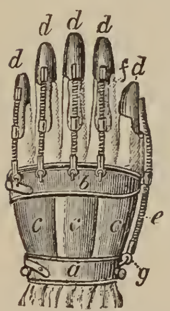


Fig. 197.—Nyrop's Apparatus for Flexion-contracture of the Fingers.

Nyrop employs elastic traction in the following manner (Fig. 197): To German silver thimbles, *d*, provided with a slightly curved dorsal process, *f* (to prevent slipping of the

elastic cords), are affixed round elastic cords which are fastened to hooks on a German silver metarcarpal bracelet, *b*, while the elastic extension cord from the thumb, *e*, is fastened to a bracelet, *a*, situated higher, but connected with the other by elastic material, *c*, and padded inside with soft leather. Apparatus for paralysis of the extensors of the hand and fingers (Collin, etc.) may also be found of use (Fig. 198).

For finger contractures, Mathieu[45] has devised an apparatus with volar splint and a pad fastened to a long lever arm intended to bear on the vertex of the curvature, the pressure being graduated by a screw.

In fully developed cicatricial contracture of the fingers it is advisable, as a rule, to operate: to perform subcutaneous discission, detach the cutaneous cicatrix, divide it transversely and unite it longitudinally, making a curved or flap incision, especially a V-shaped incision which is continued in a Y form

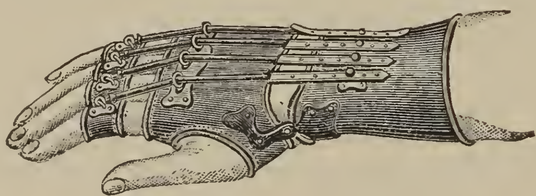


FIG. 198.—Collin's Apparatus for Extensor Paralysis.

(Busch, etc.). In serious cases of cicatricial contracture in the palm, good result may be secured from the transplantation of a pediculated skin flap from the wall of the thorax, as recently recommended by Salzer;[46] to take pediculated flaps from parts adjoining the hand can hardly be commended, since other parts would be thus endangered.

Partial resection may also have to be considered in cases of severe contracture.

Where the finger contracture is complicated with defect of the tendon, etc., and the affected stiff finger interferes with work, etc., exarticulation of the finger will be the most radical procedure, and if conjoined with resection of the corresponding head of the metacarpal bone, even the cosmetic effect will be entirely satisfactory.

In this connection, Dupuytren's finger contracture, so-called retraction of the palmar fascia (previously described by Boyer, Bonnet, and others as *crispatura tendinum*) should be

mentioned. It is a flexion contracture affecting preferably the ring and little finger of older persons, which has a tendency to increase slowly until the affected finger is completely bent into the palm (Fig. 199).

The cause of the affection has been ascribed to repeated traumata, especially in professional workmen (gardeners, carpenters, glaziers, coachmen), and this assumption has something in its favor, particularly in unilateral cases. Thus a switch-tender ascribed the affection to the vibration imparted to the hand on the switch by passing trains; a glazier, to the jarring of the hand from beating the putty into the window-frame; others, to the pressure of the head of the cane. Undoubtedly, acute and chronic traumata, especially in thin

Fig. 199.

Fig. 200.—Dupuytren's Contracture, the Little Finger mainly Affected.

hands, have some influence, although I have observed the affection several times in very fat hands, and it may occur even in people who only handle the pen (Goyrand). Heredity is blamed by some authors (Menjaud,[47] König), others assume a certain connection with rheumatic and gouty affections (Adams, etc.).

The anatomical alterations[48] present in this affection have been studied mainly by Goyrand, Adams, Blum, Kocher, and others; they consist chiefly in a retraction of the palmar fascia with connective-tissue proliferation; trabeculæ springing from the fascia fix the finger in the peculiar position and leave only the third phalanx invariably free; at times there are curved extensions toward the neighboring fingers. The flexor tendon has nothing to do with this retraction, though it is easy to mistake the prominence in the vola formed by the contracted fascia for one due to the tendon.

The symptoms of the affection at first consist merely of slight restriction of extension, especially of the ring or little finger, some tension on the volar side interfering with complete extension; at times rheumatic pains are present in the beginning, or nodal thickenings are noticed in the palm which cause adhesion of the previously freely movable skin. Gradually the finger assumes a contracted position, the flexion affecting the phalango-metacarpal and the first interphalangeal joint, while the second interphalangeal joint is never attacked.

By degrees we may notice in the palm a projection, apparently formed by the tendon, over which the skin extends in an arched fold which is adherent below (Fig. 199). The condition occasionally remains stationary in degree, but usually it is progressive, and leads to the firm flexion of the affected (ulnar) fingers into the palm, thus interfering more or less with function.

The diagnosis is simple: the predominant affection of the ulnar fingers (in very rare cases only is the index finger or thumb mentioned as implicated), the exemption of the second interphalangeal joint, the characteristic alterations in the skin of the palm, these points permit the ready differentiation of the affection from others.

Mechanical treatment, as a rule, cannot accomplish much, except, perhaps, in mild cases at the outset. Pronounced cases require operative measures. Tenotomy here, of course, would be a faulty procedure; division of the tense prolongations of the palmar fascia will remove the deformity in the majority of cases. Subcutaneous discission, especially multiple (Adams), of the trabeculæ has given quite satisfactory results in several cases. Where the retraction is very great and the skin greatly adherent, it would be good practice, in order to avoid laceration of the skin during extension, to select a more thorough procedure which will be free from danger if performed antiseptically (best by Esmarch's bloodless method), viz., either transverse division of the trabeculæ, through a longitudinal incision (Goyrand, Hardie[49]) or the formation of a square flap (Richet).

Busch's method may be most warmly recommended: a triangular flap, its base directed toward the fingers, is dissected off at the point of retraction, and while the finger is

being stretched the tense bands are divided until extension can be completed, when the wound is united longitudinally.

Gersuny and Kocher[50] have operated successfully in several cases by making simple longitudinal incisions and dissecting off the skin from the thick, firm, projecting bands, and then excising the palmar fascia with its processes so far as it is diseased. They therefore recommend the thorough extirpation of the thickened and contracted palmar aponeurosis with its processes, after simple longitudinal incision of the skin, as the correct method for the radical cure of Dupuytren's contracture.

II. Genu Valgum and Varum.

Under the term genu valgum (knock-knee) is understood that deformity where the bones of the legs form with that of the thigh an angle opening outward, or, in other words, where the knee projects inward from a line drawn from the head of the femur to a point midway between the malleoli. Genu valgum is an abduction contracture, as is well shown in Fig. 204.

This deformity is rarely congenital (Dittel, etc.), but, as a rule, forms when the child begins to walk. Formerly genu valgum rachiticum was distinguished from genu valgum staticum or adolescentium (Fig. 202) which first appears in infancy.

Mikulicz first suggested that the latter form was also usually of rachitic origin, and therefore it is preferable to speak of genu valgum rachiticum infantum (Figs. 42, 201), and of genu valgum adolescentium.

The deformity appears with greatest frequency between the ages of two to four, or later between the ages of twelve to eighteen in the male. Bakers, carpenters, waiters, etc., or men who are obliged to stand most of the time, are peculiarly liable to be affected.

Rarer varieties of genu valgum are those which follow on congenital luxation of the patella (Maas, Middeldorpf), that which is of paralytic or traumatic origin (Seydel, Mikulicz) and that which results from disease of the joint, the so-called genu valgum inflammatorium (Volkmann, Maas, and others).

Various degrees of knock-knee have been distinguished. As a rule, the degree may be accurately enough measured by

the eye. For more careful estimation Tillaux, Roberts, Mikulicz and others, have devised special instruments. Ordinarily the tape measure will enable us to note the amount of deviation from the correct line. We thus may obtain the distance *b m* (Fig. 204), from the line *A c* (Fig. 203) which extends from the head of the femur to a point midway between the malleoli. The angle which the leg makes with an ideal line extended from the femur will also serve for measurement. However obtained, the leg must be extended, the patient

FIG. 201.—Genu Valgum Rachiticum Sin.

FIG. 202.—Genu Valgum Adolescentium.

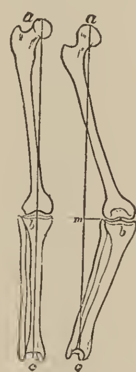
standing or reclining, and the measurement must be made in the anterior plane of the leg.

Formerly the cause of the deformity was sought in the ligaments and in the knee joint. More recent investigations have proved that it resides in the bones themselves.

The ligamentous theory, which was advocated by Stromeyer, Guérin, and Blasius, maintained that first the internal lateral ligament became relaxed, and that next the internal condyle hypertrophied; the muscular theory sought the cause in a retraction of the biceps muscle, in a paralysis of the popliteus muscle, etc. This view was held by Jörg and by Duchenne.

The articular theory of Hüter stated that the cause of genu valgum staticum resided in the form of the condyles, that is to say, it was claimed that the articular facet of the external condyle of the femur was abnormally deepened by pressure of the semilunar cartilage, and that the condyles of the femur and of the tibia remained relatively too low from lack of development.

It is to-day established that the cause of knock-knee resides in changes in the bones. While formerly the partially erroneous view prevailed that the chief alteration was hypertrophy, leading to abnormal height of the internal condyle of the femur or else levelling of the external condyle (usually secondary in nature), the anatomical researches of Mikulicz, Weil and others, have proved that the first changes are to be sought to a less degree in the epiphyseal ends than in the diaphyseal, especially the lower diaphysis of the femur, and further that genu valgum in children depends on the fact that the epiphyses of the femur or of the tibia are set obliquely on the diaphyses as the result of rachitic change in the diaphysis (unequal impregnation with lime).



FIGS. 203 and 204.

Neudörfer claims that the most frequent cause of genu valgum is diminished obliquity of the neck of the femur in relation to the shaft. This may occur without rachitic changes and is rarely congenital but almost always acquired.

The post-mortem findings have certainly at times revealed lengthening of the internal condyle of the femur, but this was secondary in nature (Chiari, Guéniot, Lannelongue, and others). An essential alteration in the profile curve has, however, not been determined. Usually more or less marked rachitic changes have been found. The affected bones have been abnormally soft; in half-grown children the epiphyseal ends have been considerably broadened, especially at the expense of the germinative zone. Occasionally the process of growth near the epiphyses has been unequal in degree, and there has existed an abnormal curvature of the entire diaphyseal end. The cartilage of the joint is occasionally found in a state of atrophy on the outside, while internally it is hypertrophied.

The changes are, as a rule, most marked at the end of the femur, rarely at the upper extremity of the tibia. In aggravated instances the patella is occasionally found pushed outward. In old age arthritis deformans may be an accompaniment.

A predisposing cause of genu valgum is abduction and outward rotation following on extension. Abnormally continuous extension position, particularly where the bones are rachitic, leads to unequal pressure and to disturbances in growth. There can be no question but that in tired individuals with weak muscles, prolonged extension of the limbs results in changes in the bones, and the prolonged unequal pressure is followed by unequal growth. Therefore genu valgum adolescentium is also static in source, even though rachitic changes ordinarily are the prime cause.

Mechanical causes may also apparently be influential in the production of knock-knee. Lücke [51] has claimed that the elastic stocking supporters worn by children may, in case the general nutrition is poor, lead to genu valgum.

The symptoms of knock-knee are a greater or less inward position of the knee, an outward projection of the lower limb, and a varying degree of separation of the feet. These phenomena may be uni- or bi-lateral. When the limb is extended the angle formed between the tibia and the femur becomes especially marked. A characteristic point is the fact that on flexion of the limb the deformity disappears. Various explanations of this fact have been offered. Hueter and Girard claim that the reason is the shape of the condyles of the femur; others believe the fact due to compensation by outward rotation of the hips; Mikulicz and Albert [52] are probably right in their assumption that the disappearance results from the obliteration of the anterior plane of the tibia and the femur when the knee joint is flexed.

In marked instances of knock-knee the walk of the individual is more or less altered. In case of unilateral genu valgum the shortening is compensated by sinking of the pelvis. In aggravated bi-lateral instances the X-shaped limbs continually interfere. In consequence the individual keeps the knee flexed and the hips are rotated outward, in order that the knees may as far as possible not strike one another. The subjective symptoms are diminished power of resistance to

labor and fatigue. Where the muscular system is weakened the symptoms are more pronounced, especially if the genu valgum is complicated, as it not infrequently is, by pes valgus. In case of unilateral genu valgum a skoliotic curvature of the spinal column often develops, beginning as a lumbar skoliosis in the direction of the shortened limb.

The symptoms noticeable from the side of the knee, especially in children, before any marked deformity exists, are pain on its inner side, inability to stand for a long time, etc. These symptoms will frequently suggest irritability of the joint due to an inflammatory process.

Fig. 205.—Locomotion in Case of Genu Valgum.

In individuals in whom the musculature is not weak, there frequently develops a compensatory supination, that is to say, the muscles opposed to those which keep the foot abducted and pronated resist and abduct the foot, so that, notwithstanding the oblique direction of the lower limb, the foot is planted firmly on the ground.

Only in case of infantile genu valgum is the deformity likely to become rectified. As a rule, genu valgum, especially in youth, has a progressive tendency up to the twentieth year, when the growth of the bone being completed the deformity remains permanent. Occasionally, however, a similar result occurs earlier, and this is to be explained on the assumption that the yielding bone has consolidated. In general, treatment is most effective the earlier in the disease it is instituted. Knock-knee of long duration calls for most radical methods of treatment. The prognosis is very unfavorable in chronic cases where arthritis deformans has developed, and in such an event the limb may become entirely useless.

The treatment of genu valgum varies greatly according to the degree and the age of the patient. It is symptomatic of progress in our art that an affection which no longer than fifty years ago was considered incurable, aside from its occurrence in young children, to-day may be looked upon as almost uniformly curable by one or another of the methods at our disposal. Infantile genu valgum must be considered separately, seeing that it rarely requires operative measures, but may be cured through resort to orthopedic devices and apparatus.

The treatment of genu valgum must subserve two purposes: It must restore normal function to the affected extremity, and it must fulfil the esthetic indications, that is to say, give the limb the natural appearance. The simple section of the external lateral ligament, of the tendon of the biceps and correction of the curvature in the middle of the lower extremity will not alone suffice (Mikulicz). There are two methods at our disposal: the one is the gradual and the other is the forcible correction of the deformity. The first is especially applicable to the deformity in children, and the aim is secured by apparatus and orthopedic appliances. The second method is preferable in case of adults and particularly in case of dispensary patients, who can neither spare the time required by mechanical treatment, nor afford the expense of apparatus. For this class of patients the operative measures, of which more than a dozen have in modern times been suggested, are suitable.

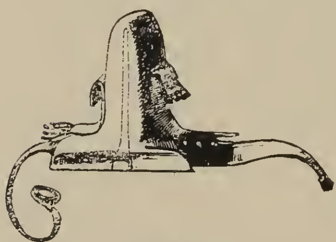


Fig. 206.—Heine's Conical Cushion.

In case of bilateral genu valgum of slight degree, one of the simplest methods is the use of a cushion (Fig. 206), which is fastened between the knees and then, by elastic traction over the ankle joints, the feet are drawn together. This method may be readily resorted to at night. A further simple method is Langenbeck's, which consists in making traction on the knees outward. This method, however, is open to objection on the score that it weakens the ligaments and it is therefore not used much nowadays.

We may divide the appropriate apparatus into those which the patient may wear and attend to his occupation, and into that which necessitates rest in bed. Of the latter variety the simplest of all is an elastic traction splint (Tuppert, etc.), placed on the outside of the extremity, to which the knee is strapped. In children this method is open to the objection that the splint is apt to slip from outward rotation and flexion of the knee, and therefore quickly becomes useless. It is preferable, hence, to immobilize the pelvis and the foot at the same time, and with this end in view the Sayre-Wolf coxitis splint may, among others, be resorted to. This is the method advocated by Neudörfer.

J. v. Heine[53] has described a number of useful orthopedic apparatuses for the correction of genu valgum. Among others we note the following: He applies a plaster bandage to the limb extending from the toes to the perineum. He imbeds in this on the outside of the limb, above and below, iron stirrups, the lower one carrying a small wheel. An elliptical piece is cut from the bandage on the inner side at the knee, and a splint is adjusted on the outer side of the limb. There is a groove in this splint in which the wheel fits, when the knee is drawn against the splint. Rotation of the lower extremity is impossible when this apparatus has been adjusted,

FIG. 207.—Heine's Plaster Bandage, with Splint.

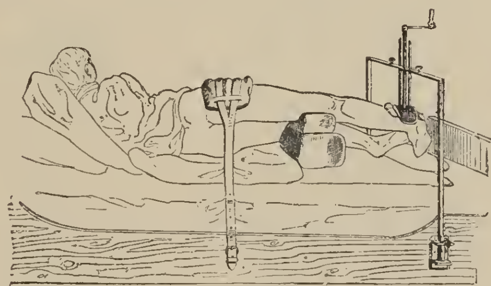


FIG. 208.—Heine's Apparatus for the Treatment of Genu Valgum.

and gradual redressement of the deformity is attained. The apparatus in position is shown in Fig 207.

A second method of treatment requires rest in bed. The patient is placed on the side, one leg is bent out of the way, and the other is straightened against a conical cushion which rests behind the knee. Pressure is exerted over the malleolus by a screw-mechanism which is attached to the foot of the bed. The pelvis is firmly strapped down. The pressure exerted by the screw is at the outset gradual, and is increased as the patient becomes accustomed to the position. Fig. 208 amply explains the procedure.

The special apparatus which, for evident reasons, is only applicable to older children and adults, consists, ordinarily, of two longitudinal steel bars, which articulate at the knee and are provided with mechanism by means of which abduction

is possible. The upper and the lower extremities are immobilized by straps and a suitable knee-cap controls the knee. The entire apparatus is attached to the pelvis by a pelvic band, and it articulates below with a special shoe. Apparatus of this nature may be worn in walking, and the deformity is gradually overcome by screw pressure. Heine, Lonsdale, Beely and others have perfected such apparatus.

A further variety of apparatus utilizes the inner projecting side of the knee as a fulcrum, the lower portion of the extremity being drawn against a horizontal splint, placed along the inner side of the limb. Hester, of Oxford, has devised appara-

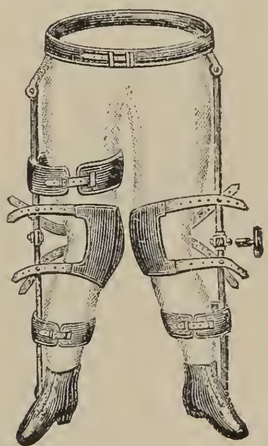


FIG. 209.—Apparatus for Bi-lateral Genu Valgum.

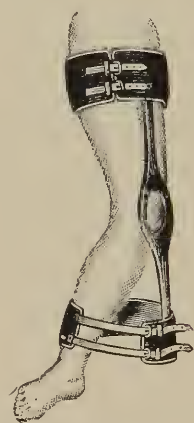


FIG. 210.—Hester's Genu-Valgum Apparatus.

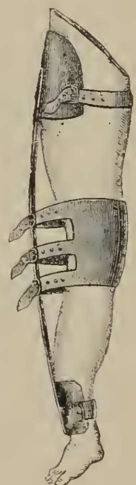


FIG. 211.—Tuppert's Genu-Valgum Apparatus.

tus of this nature, and it has been modified by Heather Bigg. It consists of two arms of a lever united at the level of the internal condyle of the femur by a ring, the whole having the shape of the normal extremity. The upper portion is strapped to the thigh, while the inferior portion of the extremity is drawn to the lower part of the apparatus by well-padded straps as firmly as the patient can bear.

Apparatus with articulated joints may quickly get out of order, and the non-articulated is therefore not alone simpler but also more effective.

Tuppert's[54] apparatus (Fig. 211) may be recommended as very simple for the treatment of knock-knee in adults. It

consists of a flexible rod, one and one half inches broad, and about an inch thick, and the ends of which are inserted into brass plates. The plate for the femur is larger than that for the lower extremity, and they are strapped to the limb as shown in the figure. By means of a knee cap, the knee is drawn to the rod, the elasticity of which tends to restore the normal position to the limb. During the first fortnight the patient must sit or recline; thereafter he may walk around, and, as a rule, the deformity is overcome in from four to six weeks. At the end of two to three months the apparatus may be removed.

For the treatment of genu valgum infantilis every apparatus is open to objection. Landerer's method of elastic traction may be considered the simplest. It exerts a continuous pressure on the internal condyle, thus checking the tendency to excessive growth, and it removes pressure from the external condyle. The extremity has thus an opportunity to return to the normal curvature. The method consists in the use of two fan-shaped pieces of plaster, connected together by an elastic band. One piece is applied to the inner side of the thigh, and the other to the inner side of the lower extremity, the elastic band between the two being stretched, and the limb is then bandaged. Children may play around while wearing this apparatus and the pain caused by the exerted tension soon abates. In cases where the deformity is slight, the bandage need not be changed often; in cases of a higher grade, where the angle formed is 145° to 155°, four applications are requisite, or two to three months' treatment is needed. Only in the most aggravated instances do six to nine months elapse before the deformity is overcome. In Fig. 212 is represented a case of genu valgum in a female infant of five years, who was first treated by Tuppert's splint, and on account of rotation this had to be removed. Landerer's method was then resorted to, and in four months the case was cured (Fig. 213).

For dispensary treatment of children, the plaster bandage is useful. The child should be anesthetized and the deformity is corrected manually as far as possible. A plaster bandage is then applied, the knee being pressed outward. After the lapse of a few weeks the bandage is removed, the deformity further corrected, and a second bandage applied. A point on which stress must be laid is the necessity of placing a com-

press on the thigh above, and below on the lower extremity, under the plaster bandage.

In older children and in adults, the plaster bandage associated with elastic traction, is a useful method for gradual correction of the deformity.

Mikulicz[55] applies a plaster bandage to the limb in its pathological position. An articular anterior and posterior iron splint is imbedded in this bandage, as also two stout hooks on the inner side of the thigh and of the lower extremity. After the bandage has hardened a wedge-shaped piece is cut out from the inner side at the level of the knee, and on the outer side at the same level the bandage is cut transversely.

Fig. 212.

Fig. 213.

The two portions of the bandage are then simply held together by the points of the splints. An elastic band or a spring is next attached to the hooks, and the deformity is gradually overcome by the tension. In moderate instances of genu valgum Mikulicz, as a rule, succeeds in a few weeks. (*Vide* Fig. 214.)

Vogt[56] has essentially modified Mikulicz's method. He uses either the silicate of soda or the leather bandage, and I am in the habit of following his procedure in my clinic.

The differences between Mikulicz's and Vogt's procedures are apparent from a comparison of Figs. 214 and 215.

Hüter advocates applying the plaster bandage with the limb flexed, since thus he obtains diminution of the unequal pressure. He has in this way reached excellent results in

cases of rachitic genu valgum, especially when the knee was drawn outward during the application of the bandage. Other observers (König, Waitz), however, have not had the same results from the method. If now we consider these various mechanical methods of treatment of rachitic genu valgum we find that, aside from many objections to which they are open, they often require a protracted application and the final result is frequently unsatisfactory. For these reasons the aim has been to devise methods more rapid in action. Tenotomy of the biceps, and section of the external lateral ligament have been in vogue for a long time, and after these methods the

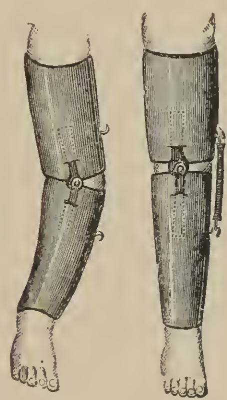


Fig. 214.—Mikulicz's Plaster Bandage.

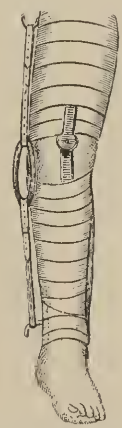


Fig. 215.—Vogt's Plaster Bandage with Elastic Traction.

deformity has been overcome to a greater or less degree. Délore [57] as the result of 200 observations has elevated rapid correction (*redressement brusque*) into a recognized method of treatment. It has frequently been resorted to successfully in Billroth's clinic, and Mikulicz [58] recommends it in cases of genu valgum infantilis where the desire is to avoid protracted treatment. By this method the epiphysis is fractured and the external ligament is torn from the lower end of the femur. Following Délore's method, the patient lies on the deformed limb and is anesthetized. The trochanter is utilized as the fulcrum, and the lower limb is held by an assistant. The projecting internal condyle is struck sharply until the deformity is overcome. Mikulicz claims that repeated attempts at re-

dressement will give more certain results, seeing that thus there occurs gradual separation of the epiphysis.

Tillaux[59] places the internal condyle on the edge of a table as the fulcrum and uses the lower extremity as the lever, straightening out the limb at once. From three to six weeks thereafter a fixed dressing must be worn.

Vogt's[60] researches have proved that the fear of disturbances in growth, etc., after the above separation of the epiphysis is unfounded. While Schede, Maas, and others recommend such measures only in case of small children, Gussenbauer applies them as well in the treatment of genu valgum in adults.

Next to manual reduction of the deformity we must consider instrumental measures, or osteoclasis by means of special apparatus as practised even by Hilppocrates, P. v. Aegina, and others. For this purpose we may use the osteoclasts

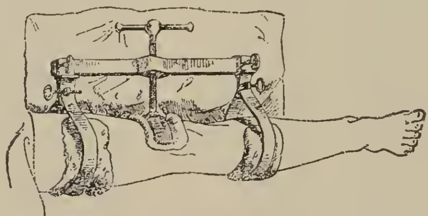


FIG. 216.—Rizzoli's Osteoclast for the Treatment of Genu Valgum.

devised by Rizzoli, Bruns, Volkmann, Beely. Especially brilliant results have been obtained from Robin's instrument.[61] Collin's instrument (Fig. 36) received the prize of the Paris Academy. Pousson claims that osteoclasis is an effective and a safe method of curing genu valgum.

In all cases of considerable genu valgum in old children or in those in whom the bones have already hardened and where gradual treatment would require too much time, or cannot be instituted owing to the social condition of the patient, the surgical methods of treatment must be considered. Especially is this the case about the twentieth year when the epiphyses have become ossified and where in consequence results can only be obtained through resort to operation. In these days of careful antisepsis the surgical methods are safe and in a few weeks cure is complete. Anesthesia and Esmarch's bandage materially lessen the difficulty of the operation.

Ogston's operation[62] (1876) of osteoarthrotomy or condylotomy with the saw, although, when performed antiseptically, it appeared rational, has to-day been replaced by better methods owing to the fact that it is based on the false premise of greater length of the internal condyle.

Ogston operated as follows: After careful disinfection of the field of operation and with careful antisepsis, the knee was sharply flexed and a slender knife about two and one half inches long was inserted obliquely above the internal epicondyle down to the bone. On withdrawal of the knife the tissues down to the knee were cut. An Adams' saw was next introduced into the opening and the internal condyle was sawn obliquely from in front backward. The deformity was then

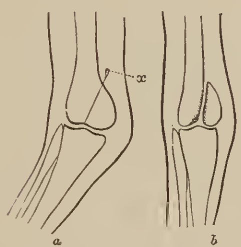


FIG. 217.—Ogston's Operation for Genu-Valgum. *a*, Schematic Representation of the Deformity; *x*, Point of Entrance of Saw; *b*, Limb after Correction.

FIG. 218.—*a*, Genu Valgum in an Adult Before Ogston's Operation; *b*, After this operation.

forcibly corrected, and the limb was encased in a firm dressing.

Although in about 300 operations, performed, among others, by Nussbaum, Thiersch, Kolaczek, Sprengler, Partsch, Bardeleben, Graeff, and others, a straight limb with movable joint was obtained, there occurred still instances where the operation was accompanied by much hemorrhage or was followed by suppuration (Sonnenburg, Schönborn), paralysis of the peroneus muscle or partial ankylosis. The operation has also been followed by death (Graeff, and others), and therefore not only have König, Volkmann, Mikulicz, and others characterized the method as a faulty one, but Ogston himself has rejected it for MacEwen's osteotomy.[63]

In 1879 Reeves endeavored to avoid certain of the accidents likely to follow Ogston's operation (such as the breaking off

of pieces of the saw in the joint) by performing condylotomy with the chisel. After making a small incision through the skin and the periosteum above the most projecting portion of the internal condyle, he applied the chisel obliquely to the bone and struck it in an outward direction. He next chiselled backward a trifle and then straightened the limb. After the lapse of two weeks he applied a permanent bandage which was worn from six to eight weeks. The more the cartilage is avoided in the operation the more certain the result.

From Mikulicz's observations osteotomy of the bones implicated in the formation of genu valgum is to be preferred to an operation on the joint. The supracondylar osteotomy of MacEwen,[64] is a simple operation and more certain in result. This operation avoids the epiphysis, the joint and the ligaments; the wound under antiseptic precautions unites by first intention; the method is not dangerous and it answers in its aim most correctly to our view of the pathology of genu valgum; it is further applicable to the majority of instances of the deformity.

MacEwen operates as follows: The patient is anesthetized and Esmarch's bandage is applied. The limb is thoroughly disinfected, laid on a sandbag and held firmly under the spray, and with a sharp-pointed knife a longitudinal incision is made a finger's breadth over the upper border of the internal condyle, and one and one half inches in front of the tendon of the adductor magnus. This incision is continued down to the bone and is made large enough for the introduction of the osteotome or even, at times, of the finger. The bistouri acts as a guide for the osteotome; the former is withdrawn and the latter is placed transversely to the bone, and is carefully driven in until it reaches the posterior border of the bone. The osteotome is next directed from before backward against the external and posterior edge of the femur.

In case of soft bones it suffices to divide the bone for two-thirds of its thickness. Where the bone is hard and brittle the section must extend just under the superficial compact layer and the remaining bridge of bone must be slowly fractured while a carbolized sponge is pressed against the wound. The limb is dressed antiseptically on a long lateral splint, and this dressing is not disturbed for a few days, unless the temperature rises above 38° C.

This method has been resorted to by Schede,[65] Maas, Trendelenburg, Schönborn, Brüns,[66] Willet, and they have almost uniformly obtained good results. A number of deaths have still been reported by MacEwen, Hofmokl, Schede; nevertheless this operation is to be commended in ninety cases out of one hundred and Middeldorpf[67] justly calls it the operation of future.

In performing MacEwen's operation Poore[68] bends the knee at a right angle, since thus he is better able to determine the mid-line, the extremity can be held to better advantage, and when the limb is straightened after the operation, the skin covers the wound in the muscles.

Reeves, Gussenbauer, Czerny and others have recommended

Fig. 219.—Genu Valgum Before and After Operation.

Fig. 220.

Fig. 221.—*a*, The Deformity to be Corrected; *b*, the Internal Incision; *c*, the same after Correction of Deformity (MacEwen); *d*, Correction after Incision in the Outer side.

and performed supracondylar osteotomy on the outside of the limb. MacEwen's operation has, however, been most frequently performed. MacEwen has done it 820 times; it has been resorted to about 1,384 times in England, and of this number ten died, although only three succumbed to the operation. In Germany also the operation has found great favor.

MacEwen claims for his method that the defect in the bone made by the osteotome is filled in when the limb is straightened, and that only in the worst cases is the bone slightly fractured on the outside and this is covered by the periosteum. Where the section is made externally, however (Fig. 221), a greater cleft results, and this is filled in more slowly. Further, he thinks that the latter method entails greater injury to the soft parts, in which the femoral artery may be involved.

Osteotomy through the diaphysis is certainly the simplest operation, yields very good results, and avoids a number of untoward sequelæ common to other methods. It is recommended by Billroth, Neudörfer, Reeves.[69]

It is performed by repeated boring through of the bone through an external incision midway between the middle and lower third of the femur. Reeves resorts to it without antisepsis or Esmarch's bandage; Billroth selects the site one and three-quarter inches above the condyles; Neudörfer uses the chisel without previous incision. The limb is bandaged and

FIG. 222.—Genu Valgum. MacEwen's Operation on the Left, Orthopedic Treatment on the Right Side.

FIG. 222 a.—Condition of the Limbs Six Weeks After Beginning of Treatment. Left Leg Straight.

this is ordinarily only changed after consolidation of the bone, that is, in from four to five weeks.

If after correction the extremity is not as long as the other, then extension must be applied. We are dealing indeed with a simple fracture of the femur, which frequently unites with slight dislocation, the upper fragment projecting outward anteriorly.

Osteectomy on the femur is somewhat more complicated.

In general, the wedge-shaped excision at the inner condyle has found but few adherents.

This operation, as described by Chiene,[70] is performed as follows: An incision from two to three inches long is made parallel to the long axis of the bone, beginning one-half an inch below the tubercle of the internal condyle and extending above it. On incising the fascia, the tendon of the adductor magnus is laid bare. The wound is extended between this tendon and the fibres of the vastus internus, the arteries are ligated and severed. A cruciform incision is made into the periosteum and this is pushed up till the bone is exposed. A wedge-shaped piece is next removed with the chisel and hammer from the base of the condyle, just above the tubercle where the tendon of the adductor is inserted. The breadth of the wedge varies according to the degree of deformity, its long axis extending downward and outward toward the intercondyloid groove. The wedge thus lies on a higher level than the epiphyseal line and its apex may reach this.

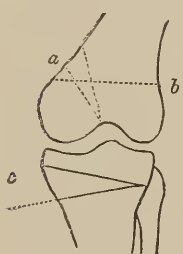


FIG. 223.—Genu Valgum Operations. *a*, MacEwen's; *b*, Annandale's; *c*, Schede.

MacEwen,[71] Mazzoni, and others chisel the wedge outside of Ogston's line (Fig. 223, *a*), its apex lying in the cartilage of the joint. The joint is not opened, and on correction the inner condyle is not fractured, but only pushed up. MacEwen, however, rejects this procedure on the ground that it is difficult of performance and uncertain in its results, compared with his linear osteotomy.

From his experience with genu valgum Neudörfer has performed and recommended osteotomy across and below the trochanter, and this is less risky than osteotomy of the diaphysis of the femur, where the canal of the bone is opened.

Operations on the tibia were performed at an earlier date (Mayer and others) than those on the femur, and where the chief deformity involves the tibia (as in rachitic instances) such operations are the most rational (Mikulicz).

Linear (subcutaneous) osteotomy is performed after Billroth as follows: Under antiseptic precautions a transverse incision one-half an inch long is made with the chisel, three-quarters of an inch below the spine of the tibia, extending through the skin and the periosteum. The compact portion of the outer surface of the tibia is then cut transversely, and the rest of the bone is

fractured. The limb is dressed antiseptically and a plaster bandage is either at once applied and left for three to five weeks, or else this bandage may be put on at the first change of dressing.

Mikulicz,[72] Gussenbauer, Volkmann, Middeldorpf, and others have reported numerous cases treated after this fashion.

Schede performs wedge-shaped osteotomy of the tibia and linear section of the fibula, an operation which Volkmann, Maas, and others also favor and which, in rachitic cases, where the deformity involves chiefly the bones of the lower extremity, is to be preferred to others. In the case represented in Fig. 42 a straight limb was hereby obtained.

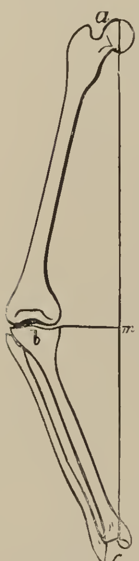


Fig. 254.

König makes a longitudinal median incision, about three and one-half inches long, through the skin and the periosteum, beginning one-half an inch below the spine of the tibia. A second incision is then made transversely and at right angles to the first, overlapping to a degree the lateral border of the tibia. The triangular skin and periosteal flaps are retracted and the periosteum from the inner and the outer ends of the incision is loosened. A sufficient wedge is then removed with the chisel to overcome the deformity, and it is essential to cut entirely through the lateral wall of the tibia. The wound is sutured, dressed antiseptically, and as soon as consolidation has occurred König allows his patients to walk. From six to eight weeks are required for union and six months before complete restoration of function.

For the great majority of cases the varieties of osteotomy suggested and resection as performed by Bauer, Annandale[73] and others are only of historical interest.

Under the term genu varum (*genu extrorsum, Säbel-Bein, genou en dehors,* bow leg) is understood the opposite condition to genu valgum. It is an adduction contracture of the knee-joint. The knee deviates outward from the normal line of the leg (*ac,* Fig. 224).

The essential seat of this deformity is almost never in the knee itself. The lower end of the femur may be alone affected

or the curvature may involve a greater extent of the limb, in particular the upper portion of the tibia, which is often also curved anteriorly. Rachitis is here also the etiological cause, and genu varum cannot be sharply differentiated from rachitic deformities of the lower extremity, for both are usually associated, and genu varum is caused by a rachitic bending of the bone near the knee-joint. Genu varum is chiefly met with in children. It may be unilateral or bilateral, and in the latter event the legs form an arc. Very exceptionally genu valgum of one side is associated with genu varum of the other (Fig. 225).

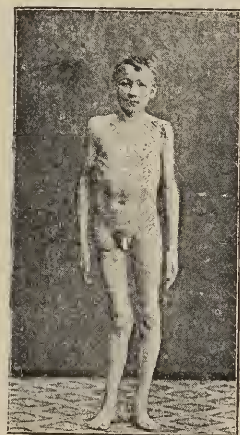


Fig. 225.—Slight Genu Varum of the Left Extremity and Genu Valgum of the Right in a 17-year-old Rachitic Subject.

The anatomical changes are those which are characteristic of rachitis. The lower end of the femur may be developed at the expense of the external condyle, the line of the knee-joint extending obliquely from within outward. The external ligament is stretched; the internal lateral ligament is tense; the essential seat of the process is in the bones, the tibia being curved to an angle opening inward (Fig. 225)—a curvature which can rarely be considered as due to infraction, but rather to disturbances in growth at the diseased epiphyseal line. In addition the diaphysis of the bones of the lower extremity is characteristically flattened out.

The symptoms of genu varum are, in addition to the diminished height of the individual, the hideous method of walking with the outward curvature of the region of the knee. Security in progression is not so much affected as it is in case of genu valgum.

The treatment in the initial stage in children consists in forbidding walking in order to spare the soft bones the effects of pressure.

As soon as the deformity becomes evident, manual correction and fixation by a suitable apparatus are indicated. These aims are best fulfilled by applying an internal lateral splint thoroughly padded near the internal malleolus, and by making elastic traction on the knee against the splint.

15

For older children a variety of apparatuses is at our disposal. The essential of the majority is a splint against which the extremity rests, the knee being drawn toward the splint. In other apparatus the point of greatest curvature is used as the fulcrum, and the lower end of the leg is drawn against an external splint. In bilateral genu varum of slight degree, a stout cushion may be placed between the feet and the curved extremities may be drawn together by elastic traction.

The apparatus for ambulant treatment consists of two iron blades fitted to the shoes, with a joint at the knee. Against these blades the knees are held by elastic traction; or else the lower extremity may be gradually straightened by the action of a spring splint fastened to the leg.

Complicated apparatus, such as that of Heather Bigg, is open to objection, and the tendency in case of much deformity is to resort to operation. At the age of about two years and under, as a rule, the leg may be straightened manually, under anesthesia, and if a suitable fixation apparatus be then applied, and anti-rachitic remedies administered, the result will ordinarily be a permanently good one. In older children forcible straightening (Délore) or else osteoclasis (the fracture of the bones, usually at the upper third of the lower extremity) are measures to which we may resort.

Where the deformity affects chiefly a single bone, such as the tibia, and this bone has sclerosed, that is to say, the rachitic process has become cured through sclerosis, then manual straightening is no longer to be thought of, and the instrumental means at our disposal find their application.

A simple linear osteotomy (Langenbeck), performed preferably with the chisel, as a rule will suffice to straighten the limb, and only in case of great deformity is it requisite to resort to a wedge-shaped osteotomy.

In Fig. 226 is represented a case of Middeldorpf's where he performed linear osteotomy on the tibia of a patient aged nineteen, and removed a wedge from the fibula. The result is shown in Fig. 226 *b*, the cure being complete.

In exceptional instances, the deformity is so great that repeated osteotomies are called for. MacEwen [74] records a case where osteotomy was performed ten times before the limb was straightened.

Theoretically, where the tibia is curved, its outer side should

be incised and chiselled and the inner side should be fractured, but it is simpler to cut the inner superficial portions together with the external wall of the tibia, and the fibula must also be chiselled in case it cannot be bent or fractured.

Resection, in case of genu varum, as performed by Howse,[75] is scarcely indicated.

The rarest form of deformity of the knee is the genu recurvatum. The condition here is one of hyperextension, the thigh forming with the lower extremity an angle opening forward. This deformity may be congenital (Kleeberg, Chatalain, Maas, and others), or acquired from inflammatory (tabetic affections of the joint, Westphal and others) or due to traumatic

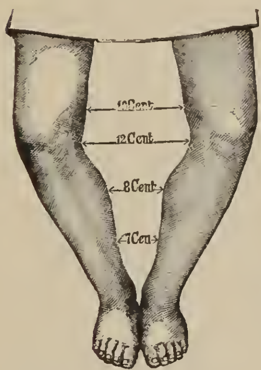


FIG. 226 a.—Genu Varum.

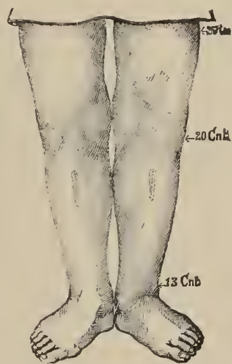


FIG. 226 b.—The Same After Osteotomy.

FIG. 227.—Genu Recurvatum.

cause. Usually this deformity is of paralytic origin (Hüter), the movements of the joint not being limited by the normal muscles, and the ligaments being relaxed (Fig. 227).

This deformity may be so marked that, as in a case reported by Bauer, on the assumption of the dorso-recumbent position the limb projects vertically upward. As a result of this deformity, the gait becomes uncertain, the pelvis sinks on the affected side and occasionally a static skoliosis develops. The treatment depends on suitable apparatus.

III. Rachitic Curvatures of the Diaphyses.

We have seen that a large proportion of the curvatures affecting the knee are rachitic in origin; similarly the curvatures of the diaphyses are caused by the same disease.

Rachitic curvatures of the femur are of little interest, seeing that we cannot do much in the way of treatment. Schede's vertical suspension in case of small children, osteoclasis, osteotomy in the worst instances, these measures are at our disposal.

Of far greater importance, owing to their frequency, are the rachitic curvatures of the lower extremity (crus varum). These curvatures affect in particular the lower third of the extremity. The curvature is ordinarily met with in the anterior plane, although curvatures in various planes occur, giving rise to the characteristic badger-legged deformity. Exceptionally the curvature is regular, and usually there is a sharp

FIG. 228.

FIG. 229.

FIG. 230.—Rachitic Curvatures of the Lower Extremities.

bend a few fingers' breadths above the ankle-joint, where an angle exists (Fig. 233), the feet gradually assuming a position similar to that of flat-foot. In exaggerated instances the deformity is not only a hideous one, but the function of the limb is materially interfered with. This almost always yields to the pressure of walking or standing, and after the cure of the rachitis there remain changes in the bones. The bones which were formerly abnormally soft become sclerotic, and have been bent and flattened by muscular action in a characteristic manner (Fig. 231).

In connection with this deformity we often speak of equalization of the deformity by growth, and unquestionably, even in instances of great deformity, the formation of new bone, in course of time, gradually fills in the concavity of the curvature, and the limb may become entirely straight.

These curvatures, however, in the majority of instances become permanent and call for special treatment. As soon as the deformity is noted, the child should, as far as possible, be prevented from walking and standing, and the ordinary anti-rachitic remedies may arrest the changes in the bones. The application of splints and of extension apparatus may also prove serviceable. The simplest apparatus is a long internal wooden splint, well padded at each extremity, to which the limb is drawn by one broad or by a number of slender elastic straps.

The majority of orthopedic apparatus suitable for these cases (Heather Bigg,[75] Salt,[76] Ford[77]) consist in one or two lateral splints fastened to the leg at the knee and foot, and with elastic straps for traction on the limb above the convexity of the curvature.

When the curvature is purely anterior, the best apparatus consists in two lateral bars with ankle-joint attachment, splints for the calves, and a leather cap for application in front over the curvature and gradually tightened to correct the deformity.

Figs. 231 and 232.—Marked Curvature of the Lower Extremity with Anterior Angle.

Where, however, the deformity is very marked and the patient is an infant, then an orthopedic apparatus cannot be well applied. A forcible straightening of the limb, even if this results in fracture, is the method which will yield the speediest result.

Forcible straightening of the limb is accomplished readily by grasping the lower extremity above and below the deformity, placing the thumbs on the most projecting portion of the curvature, and then the exertion of a gradually increasing force will accomplish the aim, ordinarily without any crepitant sound.

Where simple manual osteoclasis will not suffice, then the osteoclast of either Robin, Collin, or Beely may be resorted to. If this instrument be not at hand, and the bones are sclerosed and therefore cannot be broken manually, then osteotomy is indicated.

Figs. 233 and 234 prove how even marked deformity may be relieved by osteotomy. The patient was thus cured by me

the present year. A short incision down to the bone is made over the most superficial portion and the tibia is then nearly chiselled through and the remnant broken, or else a wedge-shaped piece is removed. The periosteum, of course, is pushed to either side.

The fibula, which is ordinarily flattened, must usually also be cut. The so-called vertical osteotomy of Ollier possesses certain advantages in that shortening of the limb is less likely to result.

It is rarely essential to perform tenotomy of the tendo Achillis in order to maintain the limb in the correct position.

FIGS. 233 and 234.—Rachitic Curvature of the Lower Extremity Before and After Osteotomy. N, Cicatrix.

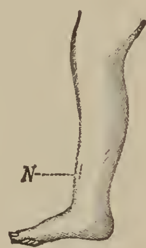


FIG. 235.

Ordinarily it is sufficient to apply an antiseptic dressing, and then a firm bandage is to be worn a few weeks.

In Fig. 235 is represented the result after wedge-shaped osteotomy of the tibia and linear osteotomy of the fibula, performed on the limb shown in Fig. 232.

Albert [78] has performed six wedge-shaped excisions on the tibia in succession and obtained union by first intention and good consolidation without the slightest suppuration or rise of temperature. I have obtained a similar result in five severe instances operated upon during the past few months. In only one case did a small fistulous opening remain for a few months after normal consolidation. This fistula closed after the separation of a small sequestrum.

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CHAPTER VI.

CONTRACTURES OF THE FOOT.

UNDER the term Talipes (club-foot, pied bot, pes contortus) are grouped together those deformities which consist in an abnormal position of the foot, or of its divisions, in relation to the leg or to each other. Since we usually find alterations in the fasciæ and ligaments, and retraction of certain muscles, these deformities are also termed contractures of the foot (*Fusscontracturen*). A division is commonly made into contractures of the ankle (talo-crural) joint and contractures of

FIG. 236.—Talipes Equinus.

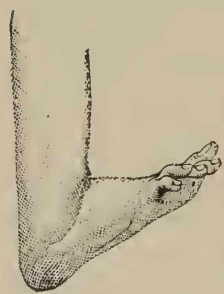


FIG. 237.—Talipes Calcaneus.

FIG. 238.—Talipes Varus.

the tarsal joints. Under the first head we have: 1. Talipes equinus (flexus) (Fig. 236), in which there is abnormal extension (plantar flexion) of the foot; 2. Talipes calcaneus (extensus), in which the foot is flexed dorsally, and the heel seems to be lower than normal (Fig. 237).

The contractures of the tarsal joints, where, in addition to a vertical displacement, there is also a deviation in other directions (adduction or abduction, pronation or supination), are divided into: 3. Talipes varus (flexus adductus inflexus), in which there is supination or adduction (Fig. 238); 4. Talipes valgus (extensus abductus) or flat-foot, in which the contrac-

tion is in a direction of pronation or abduction (Fig. 239). We have also, according to the condition of the plantar arch: 5. Talipes planus (reflexus) or flat-foot, in which the arch is sunken, the anterior portion of the foot, at Chopart's joint, is in a manner bent upward, and the entire sole rests upon the ground (Fig. 239); 6. Talipes cavus (inflexus), in which the arch is higher, the sole seems excavated, the anterior portion of the foot, at Chopart's joint, is bent downward, and this part and the heel are nearer each other (Fig. 240). In the great majority of cases none of these deformities exists alone, but they are usually combined, as, for example, in talipes equinus there is usually more or less deviation to the inner side (talipes

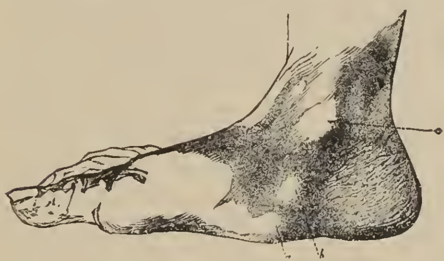


Fig. 239.—Pes Valgus.

Fig. 240.—Pes (Calcaneo) Cavus.

equino-varus), or the heel is depressed and the foot is pronated and abducted (calcaneo-valgus).

Without doubt, hereditary influences are concerned in the production of club-foot, and deformities of this kind may often be traced through several generations. Indeed, talipes has not infrequently been noted in the fœtus (Little, Parker). K. Roser [1] found among 100 malformed fœtuses, 36 in which there were deformities of the feet. Of these there were 8 cases of double talipes varus, 11 of double calcaneus, 9 in which both varus and calcaneus existed, and 9 in which there was unilateral deformity.

Deformities of the foot may be either congenital or acquired. The former are usually bilateral, and consist in an abnormal shape and position of the bones of the foot, more particularly of the tarsus. Acquired club-foot is most commonly consecutive to disease of the nervous system (neurogenous), in which the cause of the deformity lies outside of the foot; less frequently it follows disease of the bones or joints (arthrogenous), or occurs as a result of fracture or subluxation (traumatic).

The relative frequency of these different forms varies greatly, but club-foot in general is of rather common occurrence. Stromeyer [2] calls it one of the great sources of human misery, especially among the lower classes, and says that in almost every large hamlet one or more individuals may be found whose existence is embittered by this evil, and who are hindered thereby from earning their living.

Many different theories exist as to the origin of congenital talipes, but we may here distinguish between the mechanical, and the dynamic (muscular) theories, and that of arrested development.

Hippocrates, Galen, Ambroise Paré, and others sought for a mechanical explanation of congenital club-foot, but Scarpa may be regarded as the scientific founder of this theory, for he looked upon it as a result of abnormal pressure of the uterine walls upon the affected parts. Although much has been written against the mechanical theory, and cases have been cited in which children were born with club-foot, notwithstanding the presence of a large amount of amniotic fluid, Cruveilhier was an upholder of it, and he has been followed by Volkmann, Lücke, Kocher, Vogt, Banga, Parker,[3] Conrad, and others. These authorities have instanced, in support of the mechanical theory, the presence of marks (Fig. 241) indicating pressure upon the prominent parts, although one could scarcely form a conclusion from the presence of these marks of the time at which the pressure was exerted. According to Parker and Shattuck's investigations [3] we may suppose that the feet assume different positions at different periods of intra-uterine life, and that any influences which hinder the feet from assuming the position that they ought to take at any particular period, or which keep them too long in any one position, may act as efficient factors in the production of talipes. Küstner [4] is, among others, one of the most active supporters of the mechanical theory, epecially as regards the production of varus and valgus, and he looks upon a certain degree of extension of the leg as specially favoring the production of flat-foot, since the pressure of the uterine wall thereby acts at greater advantage upon the sole of the foot, pushing it upward and outward.

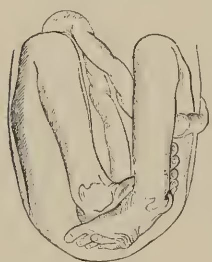


Fig. 241.—Cicatricial Contraction. (After Parker.)

K. Roser and others look upon typical congenital varus and calcaneus as instances of a true deformity due to pressure.

The fœtus lies usually with legs crossed in such a way that the outer sides of the knees and feet lie close to, if not in actual contact with, the walls of the uterus. Any movement that the fœtus may make brings these parts against the inclined plane of the uterine wall in such a way as to increase the tendency to varus, which already exists in consequence of the flexion of the lower extremities against the abdomen. The production of calcaneo-valgus is explained on the assumption that the foot is in a position of dorsal flexion at the time that it comes in contact with the wall of the uterus. When the two legs are parallel, but disposed in such a way that the outer side of one only touches the uterine wall, the effect of pressure upon the feet is to produce varus in one, and valgus in the other. The mechanical effect is similar to that seen when one walks along the side of a slope, one foot being then forced into abduction and the other into adduction (K. Roser).

In rare cases one foot may be compressed against the other in such a way as to cause marked valgus in one, and equally marked varus in the other. The well-known case of Volkmann[5] is an instance in point, and Vogt[6] has also described similar cases.

Wolff[7] regards inward rotation as the primary position, and anything that hinders outward rotation of the extremities may cause talipes varus. Velpeau believes that, in addition to the position of the fœtus, its weight may also be of some moment in these cases.

Although congenital deformities of the feet may be explained from the standpoint of mechanical causes (Hencke, Hüter), that is to say, they are the result of pressure (Roser), a proportion of the cases must be considered as due to defective development, to a primary disturbance in growth of the affected bones and joints. This view is peculiarly applicable to those instances where congenital defect in certain bones has led to talipes, and to the additional cases where there coexists deformity of another nature, such as spina bifida.

The dynamic theory as to cause, in particular the view that the deformity is the result of unequal muscular traction (Duverney, Guérin, Stromeyer will certainly not apply to congenital talipes, since careful investigation has never revealed abnormity in the muscles.

The myo-neurogenous explanation of acquired talipes has also been rejected, even in instances of paralytic deformities, that is, those which were assumed to depend on disease of the central nervous system (myelitis, meningitis, encephalitis), such disease causing an entire or partial paralysis of special muscle groups. Hüter and Volkmann have shown that here as well mechanical causes are far more influential, and that the weight of the foot, in particular its anterior portion, plays an essential rôle. The soft parts, fascia and ligaments, and even the bones gradually adapt themselves to the altered position and the consequent effect is a retraction and shortening of the antagonistic muscles. In addition to simple weight which, even where the patient is confined for a long while to bed, may lead to the formation of pes equino-varus, the pressure resulting from walking increases the deformity, the foot assuming more and more an abnormal position. Where the bones are exposed to the greatest pressure growth is diminished, and where, on the other hand, there exists scarcely any pressure, the bones increase in size. Again, where the bones are but little in contact the cartilages disappear, while a new cartilaginous surface forms where the bones constantly move the one on the other.

Spasmodic deformities, such as are met with as an accompaniment of hysteria, etc., infrequently complicate instances of myo-neurogenous talipes, and the same remark holds for the congenital and acquired spastic contractures.

Talipes may also depend on traumatic causes. Cicatrices following burns, local injury to a tendon or nerve, may lead to the deformity. Very frequently badly united fractures or subluxation result in talipes. Witness talipes valgus dependent on union at an angle of the fractured external malleolus.

In general we may differentiate three degrees of talipes: 1. Where the deformity is not marked and we are able readily to bring the foot into the normal position; 2. Where it is just possible to correct the deformity; 3. Where correction is an impossibility, the deformity being permanent.

Although the anatomy and symptomatology of talipes must be specially referred to under the individual varieties, we would lay stress here on the fact that the seat of the deformity is not alone, as was formerly the belief, in the affected joint as an entirety, but far more in changes in the form of the

bones the result of growth in an abnormal direction. In very rare instances, for example in paralytic pes equinus, essential alterations in the bones and joints may be absent. As a result of abnormal pressure, etc., the direction in which growth takes place alters, as also the shape of the bones and of the ligaments. Callosities form on the part the least subjected to pressure and these may be the source of great suffering.

The sequelæ of talipes extend generally beyond the region of the foot. There occurs an atrophy of the muscles of the lower extremity or of the entire limb which, in comparison with the normal limb, is often most striking, and this atrophy leads to marked shortening. In the paralytic forms particularly, the temperature of the limb may be greatly lowered and it may have a bluish appearance.

The symptoms resulting from talipes, aside from the peculiar method of progression and the lessened ability of endurance, are chiefly painful affections, which render the affected individual entirely unable to perform certain duties. Where ulceration and inflammatory symptoms are superadded, the patient's condition may become so aggravated as to lead him to demand amputation, as the sole measure offering relief.

The prognosis of talipes naturally varies much according to its degree, variety, and time after formation when the patient comes under treatment. The earlier treatment can be instituted the more favorable, of course, the prognosis as regards cure of the deformity.

Modern treatment is so superior to the methods formerly in vogue that the prognosis is by no means as bad as formerly, when the patient had to content himself with the variety of apparatus mentioned by Dieffenbach.[8] The introduction of tenotomy into orthopedic practice marks the boundary between the methods of to-day and of the past.

The aim of treatment in case of talipes is to restore the foot to its normal position with respect to the lower extremity, to maintain it in normal position, and to correct the shape of the foot as far as possible.

Further still, particularly in case of the paralytic forms, we are called on to increase the nutrition and the function of the part by massage, passive movements, electricity, etc.

Since treatment should be instituted as early as possible after delivery, we naturally cannot speak at such an early

period of apparatus, etc. The following measures are chiefly of importance: movements aiming at reduction of the deformity; holding the foot for a few minutes in correct position; the application at night of bandages which will maintain the foot in position. These means are applicable to the congenital varieties until the skin becomes hardened, when plaster and permanent fixation dressings are to be resorted to, and we may thus obtain gradual correction of the faulty position.

The apparatus useful in the treatment of contractures of the foot may be divided into two classes: 1. Apparatus which aims at drawing the foot from the faulty into the correct position; 2. Apparatus which will maintain the foot in the position which can be secured. A further subdivision may be made into: 1. Apparatus which acts through elastic traction and pressure; 2. Apparatus which acts through constant traction and pressure, such as the plaster bandage.

Although certain apparatus may be adapted to any variety of talipes, owing to the possibility of altering the mechanism for applying the requisite traction, the majority of the contrivances under consideration were devised for special forms of the deformity, and must be separately studied.

For the congenital varieties of talipes, in addition to manipulations and manual correction, plaster and splint bandages may be resorted to for maintaining the foot in the position obtained by manipulation. Small splints made of rubber or felt or zinc (Smith, Vogt, and others) will in this connection be found very useful. Reeves has devised a good splint. The portions for the lower extremity and for the foot are connected by a ball-and-socket joint, so that when the splint is adapted the foot may be turned in any desired direction. The feet are placed in this variety of splint in the intervals between the manipulations, and thus gradual correction of the deformity is secured.

In the construction of foot-splints, leverage has also been aimed at. St. Germain's[9] *appareil en plaquette* consists of a foot-piece ABPT (Fig. 242) and a more or less vertical (according to the variety of deformity) portion AS. In the foot-pieces are two linear openings FF. The angles SAP and SAT may be modified in the construction to suit the variety of talipes to which the apparatus is to be adapted. Strips of plaster are applied to each side of the lower extremity (D in Fig.

243); these strips are passed through the openings in the foot-piece and are then brought over the foot, to maintain it in position. A circular strip of plaster (C) surrounds the calf of the leg to retain the vertical strips, and then by means of a bandage (B) the vertical splint is drawn against the legs and the deformity is corrected.

In case of older children the chief method of treatment has for long consisted in a retention bandage, changed from time to time, the foot being secured in as good a position as possi-

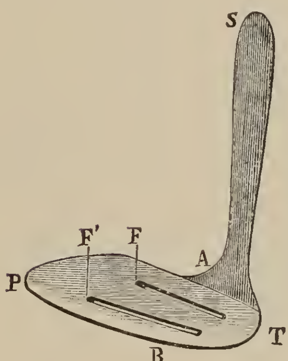


Fig. 242.

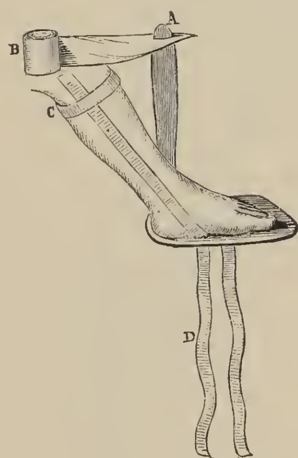


Fig. 243.—St. Germain's Splint.

ble. We will speak of this method particularly under the subject of club-foot.

Barwell's method of treatment by elastic traction through plaster is one of the simplest procedures, and it has been warmly indorsed by Sayre. It has the advantage of not interfering with the movements of the muscles and joints. A triangular, fan-shaped piece of plaster cut into a number of strips and carrying a wire loop (Fig. 244) serves as one point of attachment for the elastic traction, while a zinc splint (Fig. 245) on the front of the leg, and fastened to it by plaster, offers the second point of attachment. An elastic ligature extends between these two points and makes the desired amount of traction, the degree being regulated at will by a chain attached to the ligature (Fig. 246).

Blanc, Andrews, and others have devised similar appliances for the use of elastic traction. Andrews, for example, combines the plaster with an elastic band and utilizes a soft cushion as the fulcrum. Reibmayr has applied similar traction to talipes as to other joints.

Stillman has adapted Barwell's principle to an apparatus which is easily removed and applied to any shoe. It consists of an external splint for the lower extremity to which a number of elastic bands extend from the foot. This external lateral splint is bent backward from a point corresponding to the level of the ankle joint to the heel, where it is connected by a hinge joint with a short horizontal steel blade, to the anterior extremity of which the elastic bands are attached. At the

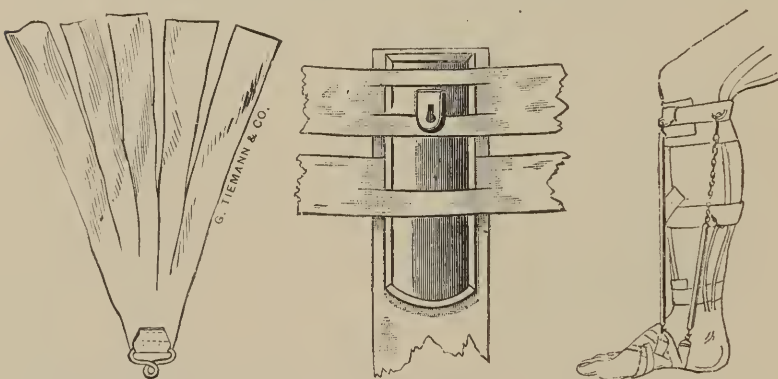


FIG. 244, 245 and 246.—Barwell's Apparatus for Treatment of Contractures of the Foot.

centre of the horizontal blade a shorter blade is attached, and this extends under the foot, and fits into a plate which is riveted into the sole of the shoe. Thus motions in the vertical axis only are possible.

Apparatus of this nature is especially useful in the paralytic variety of talipes. Beely's club-foot shoe may be taken as a type (Fig. 248). Sayre's shoe (Fig. 22) has a movable ball-and-socket jointed sole. The sole is metal covered with leather. Two lateral straight bars (B) extend from the sole, and in them, at the level of the ankle, there is a hinge joint (A). The bars are strapped to the leg at C. At the heel at J and on the sides of the sole at G there exist points of attachment for the traction chains which extend upward to the leg and backward to the heel. The chains or rubber bands (E)

act as artificial muscles. Apparatus of a similar nature to this has been frequently devised.

The Lück and Wolfermann shoe, devised for pes varus, valgus and equinus, is a further instance of a universal club-foot shoe which acts through elastic traction (*vide* Fig. 21).

Non-ambulant apparatus is also resorted to in the treat-

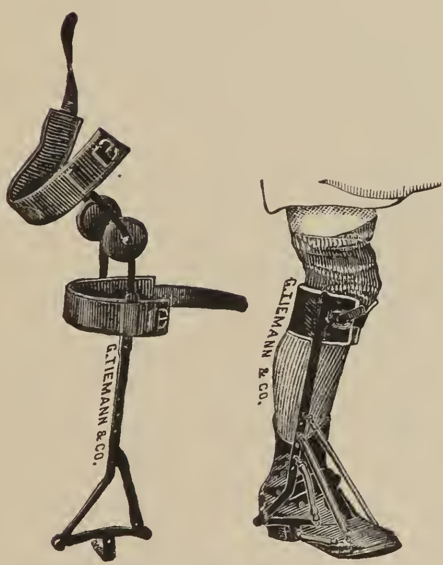


Fig. 247.—Stillman's Talipes Apparatus with Elastic Traction.

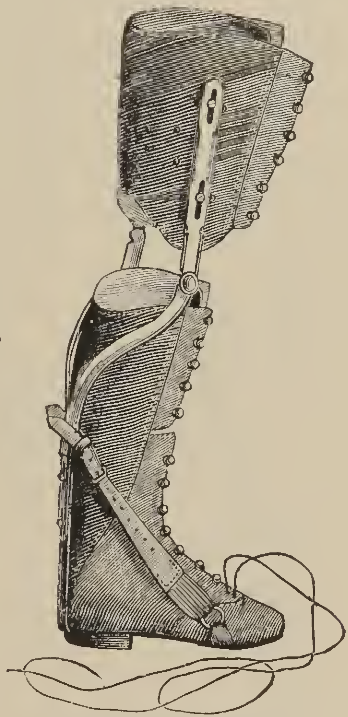


Fig. 248.—Beely's Talipes Shoe.

ment of talipes. Hansmann has devised an extension apparatus (Fig. 249) which he has tested chiefly in the Hamburg hospital. This apparatus enables us to maintain the foot in any desired physiological position and it is therefore useful, not alone in the treatment of fracture of this region, but also in case of talipes. This apparatus consists of a flat wooden splint, thirty-one inches long and seven inches wide, with an excavation for the reception of the heel. At its lower extrem-

ity it is united to a vertical wooden foot-piece, eleven inches high; at its centre and upper extremity, on each side, there are two vertical wooden bars from which counter-extension is made. A number of holes are bored into the foot-piece, into which hooked screws are inserted. The lateral upright bars carry leaden grooves in which similar screws fit. The carefully bandaged leg and foot are strapped to the longitudinal splint as is represented in Fig. 249. By varying the traction direction of the chains which are attached to the screws, the foot may be held in the desired position.

In the majority of instances, after the normal form of the foot has been approximately obtained, retention apparatus must be worn to prevent recurrence of the deformity. We will refer later to suitable apparatus of this nature.

In many cases tenotomy, especially of the tendo Achillis,

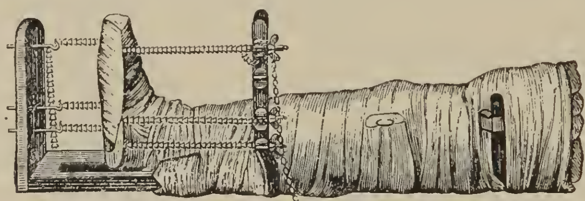


Fig. 249.—Hansmann's Extension Apparatus for Talipes.

materially shortens the time required for treatment, and whenever the contraction of this tendon is an obstacle to redressement it should be severed.

This operation may be performed with the patient lying either on the abdomen or on the back. In the first instance, tenotomy is performed from without inward, in the second from within outward. In any event the foot must be sharply flexed so as to cause projection of the tendon. A small incision is made at the edge of the tendon, a tenotome is inserted on the flat into the loose cellular tissue around the tendon, the edge of the instrument is turned toward it, and then rather by pressure (under the control of the thumb) the tendon is severed, as is evidenced by a loud snap. It is not ordinarily advisable to attempt correction immediately after tenotomy. It is preferable to wait until the slight wound has healed.

It is not often necessary to resort, in addition, to the section of other tendons, such as that of the tibialis posticus. In case

of great contraction of the plantar fascia, however, the subcutaneous section of the plantar aponeurosis may be called for. The transverse depression (Fig. 250) between the heel and the anterior portion of the sole of the foot is the site for incision. On dorsal flexion of the foot the aponeurosis projects at this spot, the tenotome is inserted either above or under it, and the shortened fascia is severed.

Of the apparatus formerly in use we will refer to Schuh's [10] club-foot appliance, since it is cheap and readily constructed by any locksmith. It consists of two separate portions: A foot-

Fig. 250.—Contraction of the Plantar Fascia.

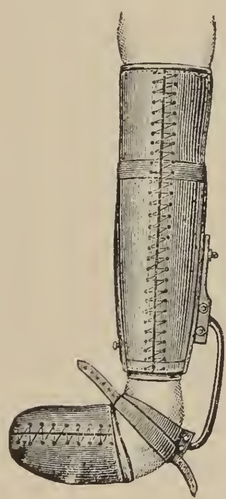


Fig. 251.—Bruns' Club-foot Shoe.

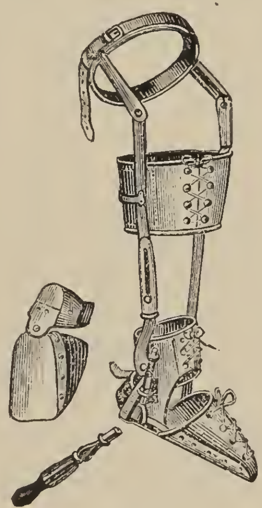


Fig. 252.—Kolbe's Club-foot Shoe.

piece of the size and shape of the sole of the foot of the patient, and a padded tin gutter which fits the lower half of the leg. From the edges of the gutter a stout ring projects An iron blade, which may be fixed at any angle, is attached to the gutter, and the bandage which holds the footpiece to the sole of the foot is drawn over this bar and the foot may thus be maintained in any desired position. Bardeleben [11] has substituted for the ring two lateral vertical projections which are connected by a rectangular piece.

In v. Bruns' [12] apparatus for varus, valgus, and equinus, the correction force is applied by the hand of the physician instead

of by screw mechanism. The foot is maintained in the position in which it is placed by the surgeon, and by repeated manipulation and adjustment of the apparatus the normal position and function are gradually attained. The apparatus consists of three portions united by bolts and iron rods, and it is represented in position in Fig. 251. Kolbe's shoe (Fig. 252) is also intended for the correction of varus, valgus, and equinus.

Under the apparatus with screw mechanism Langgaard's [13] must be referred to. It is useful both in varus and in valgus. The foot fits into an ordinary tight shoe which is supplied with an endless screw mechanism, by means of which the lateral position may be altered. Extending up the posterior portion of the shoe to the level of the ankle-joint, where it is connected with an endless screw, is a curved bar the revolution of which straightens the foot. Although this apparatus will correct equinus deformity, Adams rejects it on account of the ease with which it breaks.

Fig. 253.—Pes Equinus.

Fig. 254.—Pes Equinus Paralytic.

Talipes equinus (*spitzfuss*, *pferdefuss*, *pied bot équine*) is a deformity due to contracture of the foot in the position of plantar flexion. The heel is drawn upward, the apex of the foot downward without coincident lateral deformity of the foot.

The foot lies in a more or less straight line with the lower extremity. The patient walks on the metatarsal eminences. The foot is broad below, slender above, its longitudinal axis is shortened, whence its resemblance to the foot of a horse. In aggravated instances the patient walks on the dorsal surface of the curved toes, or even on the back of the foot (equinus dorsalis). Ordinarily there then coexists a certain degree of adduction and supination and there results the most frequent deformity: the equino-varus.

We must differentiate a pes equinus congenitus, although Tamplin rejects this variety and Adams and Little consider it very infrequent. As a rule, in the new-born, the motion of the foot in the sense of dorsal flexion is greater, and in the

sense of plantar flexion is less than in the adult. Pes equinus is more frequently acquired. The chief causes are: The effect of weight during protracted sickness (typhus, etc.), although this usually results in the pes equino-varus; inflammation of the joint, abscesses, etc., of the calf of the leg, traumatism in the same region such as burns (traumatic pes equinus); certain nervous diseases, hysteria, etc. (spasmodic pes equinus). Frequently pes equinus is of paralytic nature, the result of paralysis of the extensors, or a sequela of infantile paralysis or other central affection. We also meet with pes equinus as compensatory to shortening of the extremity due to one or another cause.

The angle formed between the lower extremity and the

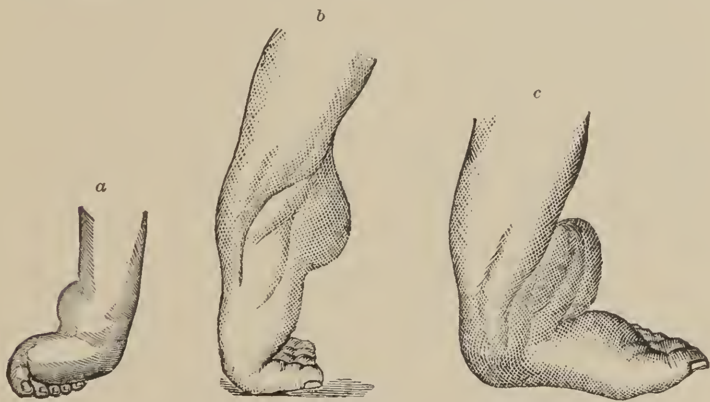


Fig. 255, a, b, c.—Aggravated Instances of Pes Equinus.

foot in mild instances is a trifle over 90,° in aggravated cases it may exceed 180°. According to the degree of deformity we may differentiate:

1. Instances where the heel is lifted upward, the toes are extended, the patient walks on the metatarsal eminences, the foot can still be placed at a right angle with the lower extremity (Fig. 253);

2. Instances where the retraction is greater, so that the axes of the foot and of the lower extremity are coincident;

3. Instances where the anterior portion of the foot is bent backward and the patient walks on the tarsal bones (Fig. 255, *c*).

In view of these varieties, the external appearances of pes

equinus differ very greatly. The foot appears to be shortened, its arch is deepened, the plantar fascia is, as a rule, contracted. The muscles of the calf, particularly in the paralytic variety, are markedly shrunken, and the entire lower extremity is atrophied. The leg, in consequence, resembles still more that of a horse. Ordinarily the head of the astragalus projects to a greater or less degree on the dorsum of the foot.

In instances where the dorsal surface of the foot is utilized in walking, the skin and the underlying tissues are thickened, bursæ are formed which become inflamed and are the source of pain. The deformity is thus greatly aggravated. In general, the degree of deformity depends on the state of the muscles. So long as the extensors functionate, the toes remain extended; while, when the anterior muscles of the lower extremity are paralyzed, the toes sink toward the plantar surface of the foot, and in aggravated cases the entire foot is retroverted (Fig. 255, *c*).

The walk of patients with unilateral pes equinus of slight degree is but little disturbed. Through flexion of the knee the increased length of the affected extremity is offset. In paralytic pes equinus, the individual drags the limb and swings it forward by circular movements. Frequently unilateral pes equinus of mean degree affects the individual more than a more aggravated type, the foot and the lower extremity functionating in a straight line like a stilt. Instances where the patient walks on the dorsum of the foot are always aggravated, especially when bursitis and ulceration complicate, and then the individual is practically helpless.

The walk of an individual with bilateral pes equinus is uncertain and lacking in normal elasticity.

The pathological anatomy [14] of pes equinus reveals rather an alteration in position than in the form of the parts which enter into the composition of the foot, except in the later stages of the deformity. In a case observed by Adams the bones of the foot were in every respect normal.

The astragalus is only in contact posteriorly with the tibia and the fibula, and projects on the dorsum of the foot (Fig. 256). The scaphoid is not infrequently subluxated, approaches the calcaneus and, in marked instances, articulates with it.

In severe chronic cases, only the posterior portion of the trochlea of the talus is covered with cartilage. In Dittel's

case, the caput tali projected above the upper surface of the scaphoid, so that the anterior articular surface of the astragalus was nearly two-thirds free (Fig. 256, *d c*).

The posterior portion of the calcaneus is lifted upward and in severe cases it may be in contact with the bones of the lower extremity; as a rule, however, its position is altered less than that of the other tarsal bones. Its anterior portion may be subluxated from the cuboid and be bare of cartilage. The metatarsi may even be in contact with the calcaneus. In Dittel's [15] case and in Chance's, new joint surfaces were formed between the tibia and the calcaneus and between the extremity of the fibula and the external surface of the calcaneus (Fig. 256, *a*).

Fig. 256.—Pes Equinus. (After Dittel.)

The tarsal bones, on the dorsal surface where the pressure is the least, increase more in size than on the plantar surface. The arch of the foot becomes unusually deep. If the toes remain in normal position (the individual being recumbent), then the metatarsi are subluxated when the individual is erect. The ligaments and aponeuroses take part in the abnormal changes. The ligaments (especially the talo-navicular) are stretched on the dorsal and shortened on the plantar surface of the foot. As a secondary change we must note the irregular course of the posterior tendons of the lower extremity. They form an acute angle forward as they pass over the heads of the metatarsal bones, while the extensor tendons may span the metatarso-phalangeal joints like a bridge.

Atrophy of the muscles of the calf is more or less striking. Pancoast's assertion that the soleus is almost or entirely retracted lacks anatomical confirmation.

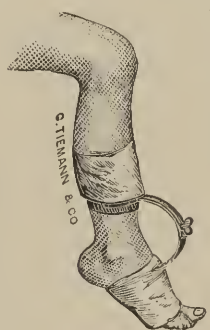
In making the diagnosis of pes equinus the knee must be extended, since, when the knee is flexed, a slight degree of equinus may entirely disappear, that is to say, it is possible to dorsoflex the foot to a greater extent.

The prognosis of pes equinus is, in general, good. The rare congenital form may ordinarily be readily corrected, as also the acquired form when of recent formation. When the deformity has existed for a number of years, the nutrition of

the joint has been deeply affected, and the component portions of the foot have adapted themselves to the abnormal position, then many obstacles are in the way of treatment. The paralytic variety, especially, calls for the protracted wearing of apparatus to prevent the development of a higher grade.

In connection with the treatment of pes equinus we must state that all forms do not call for it. The compensatory equinus, for instance, in case of shortening of the extremity, is a favorable occurrence, and then a thicker sole to the shoe will amply fulfil the indication.

The prophylactic treatment of pes equinus may be said to consist in applying suitable support to the foot during the course of all affections which necessitate protracted assumption of the dorso-recumbent position. The modern custom of using the Volkmann and other splints under such conditions will considerably diminish the frequency of pes equinus which is dependent on this cause.



Figs. 257 and 258.—Stillman's Apparatus for Pes Equinus.

In infants, manipulation, redressement, and fixation by splints will suffice to effect a cure. In older children, forcible repeated correction with the application of a plaster or a silicate of soda bandage will accomplish the aim. In severe cases of pes equinus, gradual correction after Stillman's method is possible. The splint shown in Fig. 258 is applied to the foot and the lower extremity. A plaster bandage surrounds the two portions of the splint, and these are gradually approximated by the screw mechanism in the bar connecting them (*vide* Fig. 257).

In the slighter grades of deformity the treatment is of the simplest possible kind. A piece of cloth may be looped around the patella, another piece around the foot and the two are connected by a third or by a strap whereby reduction may be gradually accomplished. Or, better still, a wooden foot-piece

may be attached to the foot and a cord may be extended from its anterior end upward to the patella, where it is fastened to a strap. By shortening this cord, gradual correction is obtained. Braatz's apparatus (Fig. 259) consists of felt splints for the foot and lower extremity, and of an iron articular frame-work fitting under the foot and along the front of the leg through which, by means of straps, the foot is drawn upward. Another method is to carry a broad strip of stout plaster under the foot and attach it to the anterior portion of the lower extremity.

FIG. 259.—Braatz's Equinus Apparatus.

Elastic traction has in a number of ways been applied to the treatment of pes equinus. One of the best known and still frequently used appliances is the Stromeyer apparatus (Fig. 260). Its component parts are: A posterior splint, *a*, with strap, *d*, a foot-piece, *b*, movable on an axis, *c*, attached to the foot by the strap, *e*, and cords passing laterally from the footpiece over rollers in the posterior splint and revolving on the cylinder, *f*. By means of this apparatus the foot may be dorsoflexed to the desired extent.

Since the individual may walk while wearing them, the

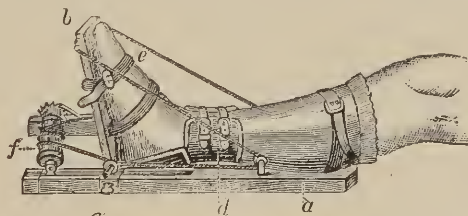


FIG. 260.—Stromeyer's Equinus Apparatus.

different apparatuses with elastic traction are more useful. Such appliances may be readily devised.

Davis, Bigg, and others recommend plaster spirals around the upper extremity, similar ones around the foot, the two

being connected by straps and rubber cords. Heidenhain [18] (Fig. 261) obtains elastic traction through a rubber ring combined with the spirals of plaster. A more efficient means is a firm bandage around the upper part of the leg carrying a hook or a ring, a similar one over the foot and an elastic band extending between the hooks along the anterior surface of the leg.

Many of the appliances with elastic traction are to a greater or less degree modifications of Bauer's (St. Louis) shoe (Fig. 262). This shoe has an iron sole articulating with which are two lateral bars strapped to the leg below the knee and at the ankle. A ring in the toe of the shoe serves for the attach-

FIG. 261.—Heidenhain's Equinus Apparatus.

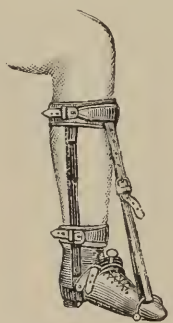


FIG. 262.—Kolbe's Shoe.

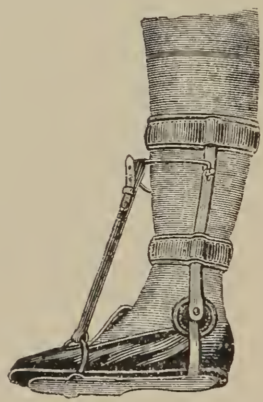


FIG. 263.—Sayre's Equinus Apparatus with Elastic Traction.

ment of the rubber band which dorso-flexes the foot. Sayre's apparatus (Fig. 263) answers the same purpose and may be fitted to the ordinary shoe. The lever instruments of Liston, Bigg [19] and others, Scarpa's shoe, apparatus with endless screw mechanisms (Parona, Langgaard) may also be utilized for the treatment of pes equinus. When, by one or another of these appliances, the correct position has been restored to the foot, the individual must wear an equinus shoe which will not interfere with walking, but which will prevent the recurrence of the deformity. These shoes have a hinge-joint adapted in them at the level of the ankle or they prevent plantar flexion through the action of elastic bands (*see* Figs. 264 and 265).

Tenotomy of the tendo Achillis unquestionably in the most

aggravated cases shortens the duration of treatment, and since this operation, performed subcutaneously, is entirely without danger, it should be resorted to. In case of paralytic pes equinus tenotomy will certainly rarely be called for. In

FIGS. 264 and 265.—Stillman's Equinus Shoes.

Figure 266 (*a* and *b*) is represented an instance of pes equinus in a boy of twelve, before and after the performance of tenotomy.

As soon as the tenotomy wound has healed, a suitable apparatus must naturally be resorted to.

Occasionally, where pes cavus complicates pes equinus, subcutaneous section of the plantar fascia is requisite. Even

FIGS 266 a and b.—Pes Equinus Before and After Tenotomy.

FIG. 267.

FIG. 268.—Pes Calcaneus.

resection of the talus may be necessary in very severe cases (Lund). In case of complete ankylosis of the joint, osteotomy may be called for, in addition to tenotomy (Billroth) or resection of the ankylosed joint after Velpeau's method. For

this purpose Reid [20] used the saw, but the operation is simpler when performed with the chisel and hammer.

Pes Calcaneus.—The reverse of pes equinus is the deformity known as pes calcaneus (*hakenfuss, pied bot calcanien*). The essence of this deformity is a contraction of the foot in a position of dorso-flexion. The patient walks on the heel and the sole of the foot is lifted upward (Fig. 267). The deformity is of common occurrence.

Nicoladoni [21] has critically analyzed this deformity. With him we may differentiate the following varieties: 1. The *pes calcaneum sursum flexus,* which is due to the flexion of the foot against the lower extremity and where the sole of the foot looks forward; 2. *Pes calcaneus* in a narrowed sense, where we deal mainly with a pure oblique position of the heel. The latter variety rarely depends on traumatism, but is usually paralytic. In paralysis of the muscles of the calf, the plantar muscles gain the ascendancy and pull the calcaneus forward and downward, the arch of the foot being thereby deepened. The first variety may either be congenital or acquired. The congenital form depends on intra-uterine disturbances, the feet, for instance, being maintained in a position of dorso-flexion. [Breech cases with extended limbs (Adams).]

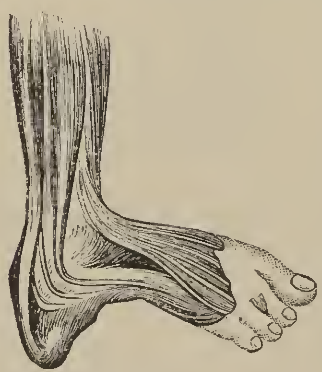


FIG. 269.—Pes Calcaneus. (After Nicoladoni.)

Parker and Shattuck believe that the deformity first appears in the later months of gestation when the normal posture is one of flexion. Dorso-flexion may extend to such a degree that the entire dorsum of the foot may lie apposed to the lower extremity. According to the angle formed between the foot and leg, we may differentiate varying degrees of pes calcaneus. The congenital form is rarely pure, but usually complicated by valgus, forming the variety known as pes calcaneo-valgus.

The calcaneus sursum flexus may further be due to paralysis. Exceptionally the cause is pathological, as in a case reported by Kundrat, where there occurred displacement of the

epiphyses consecutive to osteomyelitis with central necrosis, or as in Mensel's case,[22] where a similar separation occurred spontaneously. Pes calcaneus, further, follows on traumatic causes, such as burns and subsequent cicatricial contraction or rupture of the tendo Achillis.

Reeves divides congenital pes calcaneus into three grades:

1. Where the angle between the foot and the lower extremity is normal, yet plantar-flexion is not possible;
2. Where the angle is an acute one;
3. Where the dorsum of the foot nearly or entirely rests against the anterior surface of the lower extremity.

Acquired pes calcaneus generally depends on paralysis of the muscles of the calf. Partially as the result of weight and

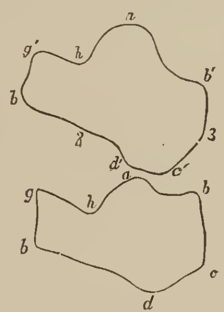


FIG. 270.—Schematic Sections of Calcaneus in Pes Calcaneus and in the Normal Condition. (Nicoladoni.) The line *b c*, the insertion of the Tendo Achillis, is bent at an angle in Pes Calcaneus.

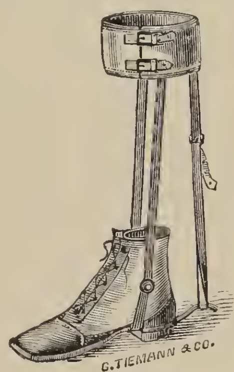


FIG. 271.—Pes Calcaneus Apparatus with Elastic Traction.

partially owing to the action of the plantar muscles, the heel is drawn downward, it becomes more conical in shape, its position more vertical—pointing directly downward like the stump after Pirogoff's operation. The tendo Achillis can scarcely be felt, the anterior portion of the foot sinks down, and in the adult the arch of the foot is more or less deepened.

As regards the pathological anatomy of pes calcaneus,[23] only in adults do we find essential changes in form. Ordinarily the position alone is altered. In Nicoladoni's case (Fig. 270) the posterior portion of the calcaneus, near the talo-calcaneus joint, was bent downward, *a′ b′*. The tubercle of the calcaneus, which normally points downward and backward, may be lifted slightly forward, *c′ d′* (Fig. 270). The gastroc-

nemius, plantaris and soleus are usually atrophied, while the deeper muscles of the calf and of the sole are healthy.

The treatment of pes calcaneus aims at lifting the heel and depressing the apex of the foot. In the congenital variety in young children these indications are readily satisfied by fastening a cotton pad between the dorsum of the foot and the anterior surface of the lower extremity, or by correcting the malposition as much as possible and maintaining the foot in good position by a splint bandage. In many cases of burns of the dorsum of the foot and of the anterior surface of the leg, we must counteract the tendency to the formation of pes calcaneus by resorting to transplantations.

Pes calcaneus may be corrected after a very simple fashion by bandaging the foot to a splint which has a projection backward like a spur. This projection is connected by an elastic cord with a band or a strap above the knee.

As soon as the individual is able to walk, the question arises of a suitable calcaneus shoe. These shoes have a metal sole with a hooked projection backward. Two lateral bars extend to the knee and an elastic band is connected along the dorsum of the leg with the knee-strap and the hook of the projection from the sole (Fig. 271). In Kolbe's shoe an articular splint surrounds the leg a hand's breadth above the ankle, and an elastic band extends from it to a species of stirrup in the shoe, and this band counteracts the tension of the tendo Achillis.

Judson [24] has devised an apparatus for paralytic pes calcaneus, the essential part of which is a hinge in each lateral splint, at the level of the ankle joint, which allows of plantar flexion, but prevents the foot from dorso-flexing beyond a right angle. In walking and standing, then, the foot is maintained at a right angle to the lower extremity.

In simple cases of deformity, H. Bigg's apparatus [25] will suffice to restore the normal form to the foot. A splint, articulating at the ankle joint, is attached to the outside of a shoe and carries an S-shaped spring extending a trifle above the ankle down to an ivory roller. The heel is thereby lifted upward and the anterior muscles are stretched. Langgaard, in his apparatus, draws the shoe, and with it the foot, downward and backward by means of a circular spring attached to the leg splint and through the arm of a lever to a vertical projection from the shoe.

In severe instances of paralytic pes calcaneus, operative measures have been recommended. Albert, for instance, aims at obtaining artificial ankylosis of the ankle joint: Nicoladoni [26] advocates the section of the peronei behind the external malleolus and the union of their tendons with the severed tendo Achillis. Hacker [27] successfully accomplished this in a young girl of ten. Resection of the tendo Achillis and subsequent suture have a number of times been resorted to. Killet performed this operation through a V-shaped incision; Walsham,[28] in four patients with paralytic pes calcaneus, excised a piece from the tendo Achillis one half to three-fourths of an inch long through an oblique incision. He sutured the tendon with catgut, and in all the cases the deformity was bettered, in two complete cure resulting. Naturally, in case of fatty degeneration of the muscles of the calf, such measures are useless. The electrical reaction of the muscles must be tested beforehand.

In many instances, where the tension of the tendons on the dorsal surface is very great, tenotomy may be requisite. Where cicatrices are at the bottom of the deformity, these must be excised and the customary after-treatment be adopted. In very severe cases osteotomy of the inferior process of the calcaneus has been advocated.

In combination with pes calcaneus and pes equinus we frequently meet with pes cavus (*pied bot talus, hohlfuss*) which rarely occurs alone. This deformity consists in an excavation of the sole of the foot with an elevation of the arch. Usually the convexity of the dorsal surface is increased and this surface is shortened.

Pes cavus is rarely congenital and is then generally due to contracture of the plantar fascia. It is usually acquired (Fig. 272), being dependent upon muscular paralysis, especially of the gastrocnemii and the solei, whereby the heel sinks downward. In the Chinese woman this deformity is artificially produced by methodical compressive bandaging and by the peculiar shoes worn. The ligaments and muscles are not specially altered in this case, and the ultimate result is a hoof rather than a foot.

In Figs. 273, 274, typical instances of paralytic pes calcaneocavus are represented. The foot is shortened, abnormally bent, with dorsal surface sharply curved, and in profile the

sole appears nicked (Fig. 273). In the upright posture there is considerable space between the sole and the ground, and in

Fig. 272.—Paralytic Pes Cavus in a Girl of 14.

Fig. 273.—Paralytic Pes Cavus in a 20-year-old Student.

aggravated cases the individual walks only on the heel and the ends of the metatarsal bones. Callosities and ulcers often form and give rise to great pain and inability to walk.

In talipes plantaris, a number of the universal club-foot apparatuses to which we have referred may be used. One of the most useful appliances is that of Bigg (Fig. 275). It consists of a steel sole strapped to the foot and which may be straightened out by means of a screw.

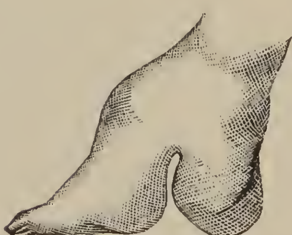


Fig. 274.—Foot of a Chinese from a Preparation in the Hunterian Museum.

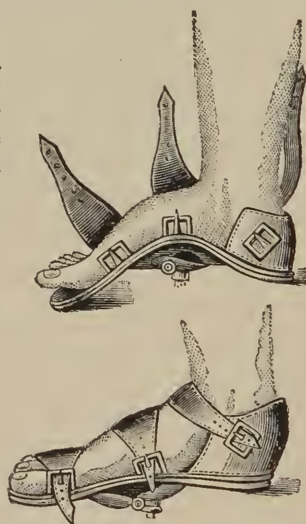


Fig. 275.

By means of tenotomy, especially by section of the plantar

fascia and of the muscles of the sole of the foot, the treatment of pes cavus may be materially altered. Where the fascia may be felt as a tense band it must be incised subcutaneously.

Where we are not dealing with single tense bands, the muscles and fascia must be severed until the deformity can be corrected, as has been done in cases recorded by Schede and others, and the wound should then be treated antiseptically. We may thus assure a good result.

After tenotomy Bauer applies a boot with an iron heel and makes vertical pressure on the dorsum of the foot through the double screw which he has devised. He was thus enabled to cure a case of eighteen years' standing.

Pes planus (splay foot, *pied plat,* spurious valgus, *platte fuss*) must be sharply differentiated from flat foot (*plattfuss*) since in case of this deformity the relation between the navicular bone and the caput tali is not altered, while in pes valgus the head of the astragalus projects inward over the navicularis. In splay foot the most essential feature is the lack of arch to the sole and of the external curvature of the foot. Pronation is not present.

FIG. 276.

The foot of the new-born is always flat and we may consider pes planus the outcome of absence of that phase in growth which leads to the arching of the foot.

Pes planus is further characteristic of many African tribes. The Jews also have a splay foot. Relaxation of the ligaments, etc., is said to be a cause of pes planus.

The foot is markedly broadened and flat, without the projection of the head of the talus which is characteristic of valgus. The arching of the sole is lacking and the bones of the tarsus, as in case of valgus, rest on the ground. The pronation phenomena are wanting. Whether splay foot tends to become valgus, as some writers have claimed, or not is questionable. Treatment is usually not requisite. Occasionally elastic adjuvants are called for.

Some writers, Emmert [29] for example, differentiate the broad foot (*breitfuss*) (Fig. 276), where the anterior portion of the bones of the middle foot are broadened out from abnormal

length of the transverse ligaments. The function of the foot is not affected. This condition may coexist with splay foot.

Pes Varus.—Under the term pes varus (*Klumpfuss, pied*

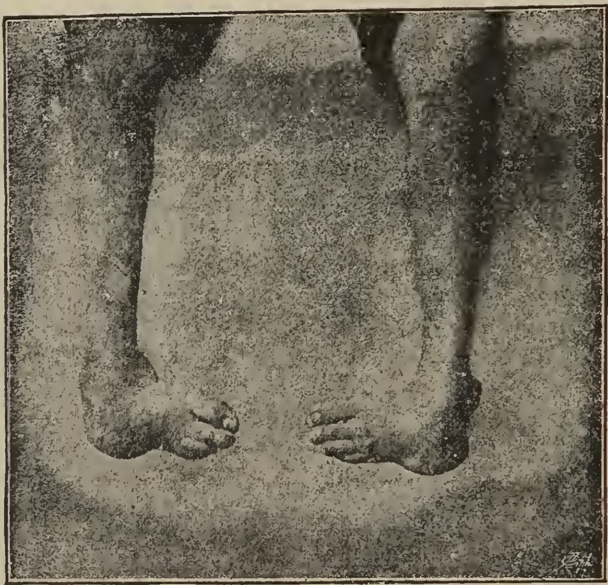


Fig. 277.—Pes Varus in a Man of 23.

bot varus, supination contracture, adduction contracture) is understood that deformity where the foot deviates inward from its longitudinal axis, is supinated and usually adducted. The apex of the foot is directed inward, the sole is curved inward, the internal border of the foot is lifted from the ground and the external border is depressed (Fig. 277).

Fig. 278.—Infantile Pes Varus.

As a rule, the talo-tarsal joint is not alone implicated, but the talo-crural joint as well. The foot is plantar-flexed, that is to say, its apex is sunken, forming a pes equino-varus, not a pure pes varus. To this deformity Henke gave the name of pes flexus adductus-inflexus.

In all small children there exists a tendency to the varus position of the foot, and we may say that this is the normal position in the fetus and that later, as a result of the at-

tempts at walking, etc., the varus changes into the normal position.

Pes varus is the most frequent of all the congenital deformities. Adams, in 764 cases of contracture of the foot, found the varus type 668 times; in 999 cases of non-congenital deformity, equino-varus occurred 162 times and pes varus 60 times. Out of 800 to 1000 men we may expect to find one instance of pes varus. The deformity affects most frequently males, it is ordinarily bilateral and when unilateral the right foot is implicated by preference (Roberts[30]), although Dieffenbach[31] claims the reverse.

We may differentiate a number of degrees of this deformity. It was formerly customary to make five divisions, but to-day the following three forms are differentiated:

1. Where the foot can still be brought into the normal position and the angle between the foot and the lower extremity is greater than 90°;

2. Where correction is not possible to such a degree, the foot being drawn more internally. There then exists contracture of the tendons and fascia;

3. Where it is impossible to correct the deformity manually, the foot being at an acute angle with the inner surface of the lower extremity, all the tissues on the inner side being shortened.

Fig. 279.—Paralytic Pes Varus in an Early Stage. Young Girl of 9.

A division, according to etiology, into congenital and into acquired pes varus is preferable. In the congenital variety, the deformity is due to a primary change in the bones, in the acquired form the causal factor, in general, lies outside of the bones, the majority of cases being dependent on paralysis, either peripheral or central, and this, secondarily, leads to deformity of the bones. The cause is rarely to be sought in spastic or inflammatory conditions or in trauma which has left lasting changes in the bones or the joints of the foot and lower extremity (the traumatic pes varus).

Congenital pes varus depends on abnormal shape and position of the separate bones of the foot and of the joints, and various explanations have been offered as to the cause of the

deformity. Esricht [32] considered the deformity the result of a persistence of the curvature of the foot which normally exists at a certain stage of fetal development; others believe it due to abnormal position of the fœtus *in utero,* claiming that the bones and joints of the foot, being subjected to pressure, are forced to maintain the varus position, and that this in the course of fetal development becomes exaggerated (Kocher [33]). This pressure is not always due to the fact alone that the liquor amnii is deficient in amount, for in a case recorded by Kocher the deformity existed in a very early period of fetal life. Indeed, the observations of Lücke, Volkmann, Kocher, Parker,[34] and Roser render it doubtful if Martin's view in regard to the effect of uterine pressure be correct. In many

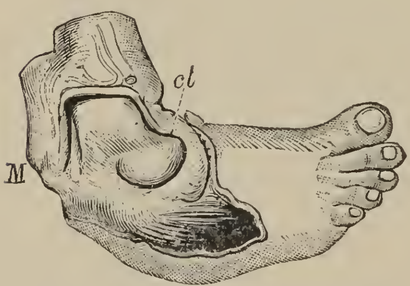


Fig. 280.—Infantile Pes Varus, the Talus being Exposed.

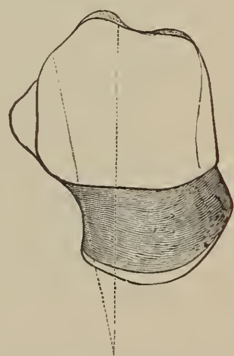


Fig. 281.—Talus of the Normal Adult.

instances it seems that pes varus may develop in the later stages of pregnancy. Parker and Shattuck have found the caput tali divided into two apposed facets, the one of which had degenerated from the fact that it had not been used, and this would seem to point to extensive capacity for motion of the feet in early fetal life.

As regards the anatomical changes [35] in congenital pes varus, Adams and Hüter [36] have shown that there exists essential abnormity in the configuration of the bones, an exaggeration in the fœtus, as it were, of the form of the bones and joints met with in the adult.[37] Kocher, in particular, has shown that not only are the talus and the calcaneus implicated, but that all the bones of the tarsal joint take part in the changes which are characteristic of congenital pes varus.

On considering these congenital alterations, we find not only the bones and joint surface altered, but also, not infrequently, abnormal changes in the lower and even in the upper extremity.

In the talus there is a constant characteristic deformity, its neck being lengthened in an oblique direction inward (*vide* Fig. 280).

While in the new-born the normal obliquity of the talus is 38°, that is to say, the sagittal axis of the talus forms an angle of 38° with a line drawn parallel with its external border (Fig. 282), and while in the adult this angle only amounts to 10.65°, in case of congenital pes varus the angle is 49.6°, the maximum being 64°, and, in consequence, as Parker has shown, the talus bears a strong resemblance to that of the ape, in whom the foot possesses great range of motion in the sense of inversion and of supination.

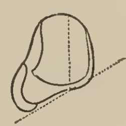


Fig. 282. — Talus from an 18-months-old Child with Pes Varus. (Parker.)

The whole body of the talus is flattened. It is sharply cut off backward like a wedge and, as a rule, it is flexed on the plantar surface of the foot. The talo-crural joint has lost the character of a hinge-joint and approximates that of an amphiarthrosis. The trochlear surface projects backward nearly or entirely to the posterior border of the lower joint surface; anteriorly this surface is worn down, the internal articular facet is scarcely recognizable, and that which articulates with the external malleolus is pushed forward. The head of the talus is directed a trifle downward, forming an angle of 65° with the axis of the talus, instead of one of 45° as in the new-born.

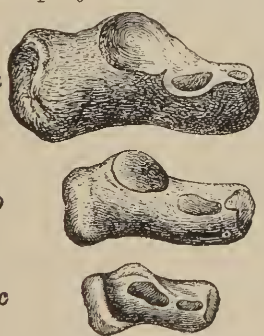


Fig. 283.—*a*, The Calcaneus, Pes Varus at One Year; *b*, the Calcaneus, Normal, in the New-born; *c*, the Calcaneus, Pes Varus in the New-born.

The articular surface of the head of the talus points inward and occasionally it is divided into two apposed facets, of which the internal alone is in contact with the navicular bone, the other being only covered with a thin layer of cartilage and by the elongated ligaments.

The calcaneus (Fig. 283) is sharply rotated internally under the talus, its tuberosity is directed toward the fibula,

and the abnormal height of its anterior process is especially striking, as also the oblique slanting of the upper joint-surface. The sustentaculum tali—the apparatus which checks supination (Hüter) and which in the new-born is much deeper than in the adult—is lacking. The articular surface for the cuboid is situated on the median side and the longitudinal axis of the calcaneus is curved so as to be concave internally and the anterior process and tubercle of the bone point inward.

The cuboid, seen from above, is quadrilateral rather than triangular in shape, and this is due to the increased lateral growth where the effects of pressure are wanting. The navicular bone lies to the inner side of the caput tali and the longitudinal axes of these bones are rather parallel than at a right angle.

The lower extremity is frequently twisted inward at its lower portion, and the end of the fibula projects forward.

FIG. 284.—The Cuboid. 1, Normal at Two Years; 2, Pes Varus (One Year).

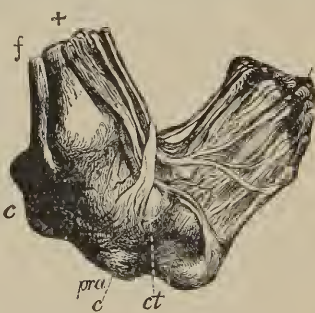


FIG. 285.—Pes Varus in an Adult.

The ligaments are altered in accordance with the change in position and in form of the bones. The internal lateral, the plantar, calcaneo-fibular and talo-navicular ligaments are shortened, and the external ligaments are stretched.

The muscles retain their normal relations. Even after section of the muscles and ligaments, entire reposition is not possible. The tendons are altered in their relation to the bones. The tendon of the peroneus longus, for instance, forms a groove on the external and under surface of the calcaneus. In a single instance Roser found a sesamoid bone in the tendon of the tibialis posticus, in its course between the internal malleolus and the first cuneiform bone. Similar changes, in the main, are found in all cases of pes varus in infants, and the feet are in a position of supination. We refer, in this connection, to Kocher's description of pes varus in

infants of one year and of three. The soles of the feet may be approximated like cymbals.

The anatomical changes in congenital pes varus of adults are of a still higher degree than in children, and they are marked especially by the formation of new and abnormal facets. The internal malleolus is less prominent, shorter and rounder, and a joint is often found between it and the navicular or even the cuneiform bones. The groove for the tendon of the tibialis posticus is very shallow. The bones are not of normal size and thickness, but they are rather osteoporotic and fatty, and the two posterior bones of the foot are most markedly altered.

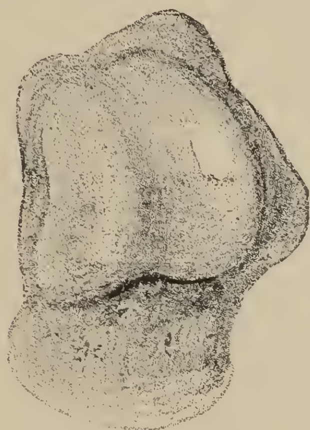


FIG. 286.—Talus of an Adult.

FIG 287.—Talus of an Adult with Pes Varus.

The talus is more slender and longer, the trochlea is, posteriorly, only partially covered with cartilage and, anteriorly, it is divided by a transverse line (Fig. 288). The lateral joint surfaces are unequal. That for the fibula is sharply pushed forward against the neck of the talus, it is larger and, at the posterior border of the trochlear articular surface, it is divided into a triangular surface. The articular surface for the tibia is generally very small. The caput tali is ill-developed, misshapen, and frequently carries two facets, of which the external is not covered by cartilage and the internal articulates with the navicular bone (Fig. 288).

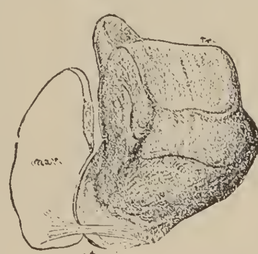


FIG. 288.—Pes Varus Sinistr. The Talus and Scaphoid. (Adams.)

The calcaneus is altered in shape and position; its longitudinal axis is curved with median concavity; its upper articular surface is flattened in the centre and so sharply pushed inward that it does not reach the eminence of the bone (supination position). The anterior portion is longer and higher and springs forward a trifle. The tuberosity projects upward and lies just behind the fibula. The upper surface of the calcaneus lies in contact with the posterior border of the articular surface of the tibia, so that in severe cases the os calcis seems to belong to the joint of the foot. The articular surface for the cuboid may be displaced entirely toward the centre.

The navicularis is also altered in form and in position. It is shaped like a double wedge, the central portion having a lesser sagittal diameter and being flattened like a wedge downward. The bone is frequently displaced under the internal malleolus and, as a rule, articulates with it by a facet, as though it had been drawn into the assumed position by the action of the tibialis posticus.

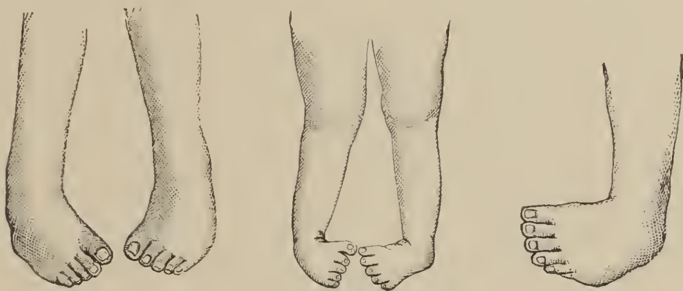
The cuboid is displaced to the same extent inward; it overlaps two-thirds of the articular surface of the calcaneus and is connected with it by the stretched ligaments. Its transverse diameter is ordinarily increased, is more quadrilateral in shape, its external surface is more convex. In a case observed by Noble Smith, the enlargement of the cuboid seemed to be the chief cause of the deformity.

The cuneiform bones are directed from above backward. They are not vertical and are more behind than near one another. The ligaments and the tendons are adjusted to the changes in the bones. Roser[38] found a sesamoid bone in the tendon of the tibialis posticus where it extends between the internal malleolus and the first cuneiform bone.

In regard to the external appearances of congenital infantile pes varus (Figs. 289–291), the tarsal joint is bent inward and shortened, the anterior portion of the foot is directed more to the front and the sole more backward; the internal border of the foot looks upward and the external downward; the heel appears very small and frequently assumes an almost vertical position. The internal malleolus is not as prominent, the external projects markedly.

In very aggravated cases, the angle formed between the

foot and the lower extremity is an acute one; the longitudinal axis of the foot lies more to the front; occasionally the foot is shortened and there exists a deep transverse depression in the sole, due to rigid contracture of the plantar fascia.



FIGS. 289, 290 and 291.—Various Grades of Infantile Pes Varus.

As we have stated, as the result of the action of weight the form of the foot is essentially changed. Since this action is not on the arch of the foot but on its external border, and the foot, in consequence, becomes greatly supinated, the individual soon walks on the dorsum of the foot.

When we meet in the adult with pes varus which has not been subjected to suitable treatment, the foot, in aggravated

FIG. 292.—Congenital Pes Varus in a Man of 26

FIG. 293.—The Same, Seen Posteriorly. (Adams.)

instances, looks like a club; the sole points upward and backward, the dorsum forward and downward; the decrease in length is the outcome of atrophy; the heel, which is drawn upward, is small, the skin tense; on the dorsum of the foot a

thick club-like callosity has developed, the subcutaneous cellular tissue being infiltrated and containing a bursa (Figs. 277, 294).

The anterior and posterior portions of the sole of the foot are separated by a deep transverse groove; a second longitudinal groove divides the sole into two halves (Fig. 293), and these grooves are characteristic of congenital pes varus, for they are not marked or are entirely absent in the acquired form (Adams).

As a result of the great atrophy of the muscles, the calf of the leg is effaced, the limb looking like a cylindrical stilt. The length of the extremity is occasionally diminished, and the appearance suggests the leg of an animal, whence the popular names "cow-foot" "devil's foot," etc.

Fig. 294.—Pes Varus in a Man of 30.

In severe instances, not only is the foot, but the lower extremity, the knee, and upper extremity are also turned inward, and in order to make measurements it is necessary to remember that the patient masks in part the inward rotation of the lower extremity by an outward rotation of the femur. "The real inward rotation is, as a rule, much greater than the apparent" (J. Wolff) and, in order to determine it, the legs must be placed with the patella exactly in front, or, when the individual is recumbent, looking directly upward. Thus this rotation is eliminated.

Acquired pes varus may be the outcome of a number of causes:

1. Disturbances of the nerves, unequal muscular traction; 2. Traumatism.

The majority of instances of acquired varus are certainly paralytic, the sequela of infantile paralysis of central origin, and, ordinarily, pressure, etc., leads to the formation of an equino-varus. In its inception we are not dealing, as in congenital varus, with a primarily deformed foot, but only with a certain degree of deviation from the normal shape. As the result of use of the foot, the acquired pes varus assumes simi-

lar appearances to the congenital. Less frequently the acquired variety may be traced to spasmodic affections, such as contraction of the supinators. An instance of this is the acquired pes varus hystericus.

Traumatism may lead to pes varus through unequal muscular traction. Thus, an injury to the peroneal nerve may cause paralysis of the pronator muscles, and, in consequence, the supinators obtain control over the foot. In the majority of instances of traumatic varus, the cause is to be found in direct changes in the affected bones, as, for example, dislocations of the tarsal joints, fractures of the tibia, of the internal malleolus, of the talus, etc. Diseases of the bones, in particular partial necrosis, may result in varus. Bartels has reported an instance following on osteomyelitis and sequestrotomy. Cicatricial contraction from burns on the inner side of the ankle-joint is a rare cause.

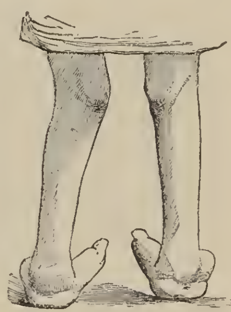


Fig. 295.—Aggravated Pes Varus.

The anatomical changes differ greatly according to the degree of the varus. As a rule, we find arrested growth and an atrophy affecting all the tissues. Essential deformity of special bones is less marked than in the congenital form. The talus, especially, retains to a greater or less degree its normal shape, the calcaneus its sagittal direction. The alterations are chiefly in the joints, leading to the so-called subluxations.

The atrophy of the muscles and of the tendons is quite marked. The external appearances of acquired pes varus are less characteristic than those of the congenital form. The general atrophy, especially in the paralytic forms, is striking (Fig. 279). The lower extremity resembles a thin stick. The bony projections on the dorsum of the foot and the depressions on the plantar surface are lacking. As a rule, the deformity is not a rigid one. In paralytic cases the livid color and the coolness of the entire extremity are striking.

As for the influence of pes varus on the individual, Dieffenbach has said, with truth, that the deformity is a greater affliction than the loss of a limb. From early childhood to the grave it is a lasting source of bitter complaint. The individual considers it a disgrace to have been thus brought into the

world. According to the degree of the deformity, locomotion is more or less interfered with; in bilateral instances, where in walking the toes are in contact, the individual progresses as though he were on stilts. The deformity cannot be concealed by the most expertly constructed shoe, and these, usually, resemble a hoof (Fig. 296).

The difficulty in locomotion often causes these individuals to resort to work which may be accomplished in the sitting posture (tailors, etc.). Dieffenbach has pointed out that many patients on being cured seek more active occupations.

The special diagnosis of the individual form depends on the appearance of the posterior segment of the tarsus, on the relation of the heel to the malleoli, on the distance of the apex of the external malleolus from the plantar surface of the calcaneus.

Fig. 296.—Congenital Pes Varus.

The clinical course of congenital pes varus is the following: With the first attempts at walking the external border of the foot alone touches the ground. The downward weight does not, as is normal, cause increased pronation, but supination of the foot. Gradually the dorsal surface serves the purpose of locomotion, and as development increases, this perverse tendency is exaggerated, the ligaments and the muscles adjusting themselves to the abnormal relation of the bones.

On the dorsal surface of the foot callosities and subcutaneous bursæ form, particularly over the projecting anterior process of the calcaneus. Not infrequently these bursæ become inflamed and suppurate, thus adding to the suffering of the unfortunate individual.

The muscles of the foot and of the lower extremity, which are not used by the club-footed in walking, gradually atrophy, even though at birth they were normal, and thus, at the outset, unequal muscular traction is at work—a factor which in case of unilateral pes varus is especially marked in the calf (Fig. 339); at times a marked shortening of the affected limb may be determined.

The therapeutic indication in case of pes varus is to convert the supination position into that of pronation. Formerly

it was the custom to defer treatment of congenital varus until the child was a year or more old. Unquestionably it is wiser to resort to treatment as early as possible, even in the first week of the child's life, particularly since J. Wolff has shown that the child's foot grows very rapidly during the first months of its existence, and that therefore the elements which interfere with correction concomitantly increase. This view is in accord with that of Albert, Kocher, König, Margary, Mensel, Sayre, Vogt, and others.

In the new-born, of course, it cannot be a question of complicated apparatus and bandages. We may attain our aim by means of suitable manipulations, traction into the normal position, that is of pronation and dorsal flexion, especially

FIG. 297.—Manual Correction of Pes Varus.

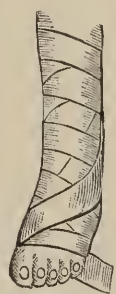


FIG. 298.—Correction by Bandage.

when, in addition, we maintain the obtained result by small splints. Thus, in a few weeks, an aggravated club-foot may be almost entirely cured.

The manipulations should be resorted to frequently and the mother may readily be taught to perform them. The lower extremity should be steadied by one hand and the other should grasp the foot and endeavor to carry it into a position of pronation and of dorso-flexion and to maintain it in such position for a few minutes (Fig. 297).

During the night, and occasionally during the day, the foot should be held by a small splint and bandage in a position as much opposed to the faulty one as possible. Splints of various material, sticking plaster, and the ordinary bandages are at our disposal for this purpose (Fig. 298).

In Mellet's "Manual" there are tabulated 150 cases of pes varus cured by manipulation and bandages.

Formerly it was customary to treat congenital club-foot in two stages: First to convert the varus into an equinus by

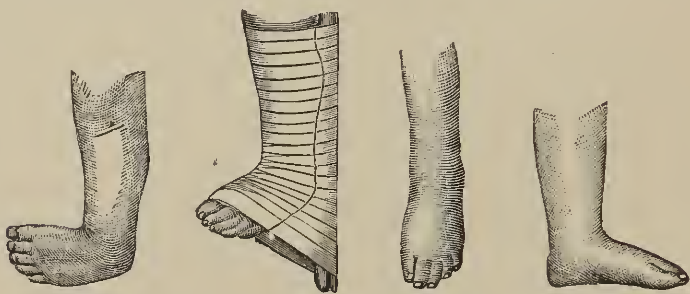


Fig. 299. Fig. 300. Fig. 301. Fig. 302.
Treatment of Pes Varus in Two Stages. (After Adams.)

means of an external wooden-splint to which the foot was bandaged (Fig. 300), and next to restore the foot to the normal by tenotomy (Fig. 302).

In Fig. 300 is shown the application of the splint to the foot and in Fig. 302 the result. Adams[39] recommends a simple, infantile varus splint which consists of a splint for the upper extremity, of one for the lower with a joint at the knee, of a foot-piece provided with an endless-screw mechanism.

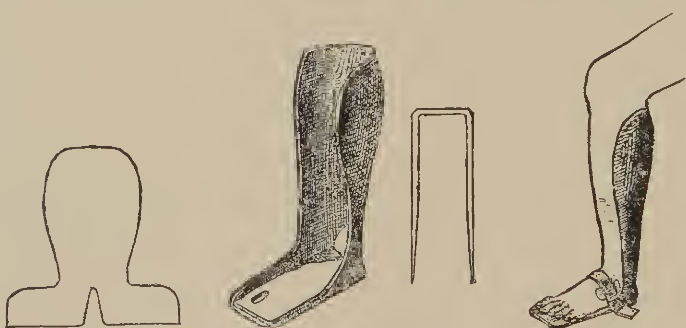


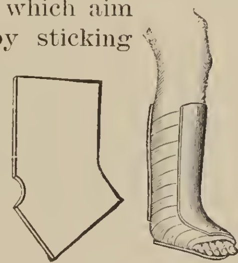
Fig. 303. Fig. 304. Fig. 305. Fig. 306.
Vogt's Club-foot Felt Splint.

Splints constructed of the following materials may be used: metal, pasteboard, leather (Paraeus, MacEwen), silicate of soda and pasteboard (Vogt), rubber (Lorinser). Felt splints

are, after pasteboard, the best, and the relatives of the little patient should be instructed how to apply them. In the infant, splints and manipulations are the chief means of treatment, for permanent bandages cannot be utilized owing to the fact that they become so quickly soiled. When the foot has been placed in the desired position, the parents may be taught to apply the felt splint, and the case, therefore, does not require the constant supervision of the physician.

Vogt shapes the felt as is represented in Fig. 303, forming a posterior splint and two overlapping portions which make the foot-piece. König prefers an internal lateral splint modelled as is represented in Fig. 307 and applied as in Fig. 308. The foot is maintained in correct position by means of a roller flannel bandage.

When the skin of the foot has become less tender, that is to say, in older children, then the methods which aim at elastic traction by sticking plaster and the permanent bandages are applicable. Strong plaster (Maws' moleskin is the best) should be cut into strips about one and one-half inches wide and bound around the foot and leg, drawing the former into a position of pronation. Fischer, Sayre, Mensel, and others, have recommended this method.



FIGS. 307 and 308.—Felt Splint. (After König.)

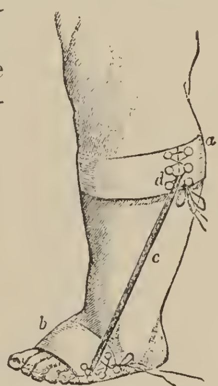


FIG. 309.—Elastic Traction. (After Willard.)

Sayre carries the plaster strip as high as the head of the fibula, places a roller bandage over it, and, when he desires greater traction, he surrounds the bandage by a second strip. Mensel [40] envelops the foot in three layers of moist gauze, and, after this has dried sufficiently, he applies strips of plaster in such a way as to keep the foot pronated. Barwell has efficiently combined elastic traction with the application of moleskin plaster (*vide* Figs. 244–246). Forest Willard carries strips of cambric, one and three-fourths to three inches wide, around the leg and foot (Figs. 309, *a*, *b*) and connects them by an elastic band. Sticking plaster may, obviously, be also used

in combination with silicate of soda, plaster-of-Paris, etc., bandages.

When the child has reached the age of walking, retention apparatus is, as a rule, resorted to. The aim of apparatus of this nature is to prevent recurrence of supination of the foot. Felt splints have the advantage that they may be worn under the clothing. Club-foot shoes, of which we will speak in detail later, answer the purpose of keeping the foot pronated. In its simplest form such a shoe consists of a laced boot carrying a flexible bar, with slightly outward spring, articulating at the level of the ankle-joint. We must emphasize the fact, however, that club-foot shoes should not be used too early, lest recurrence of the deformity set in.

In case of still older children, apparatus which acts by elastic pressure and traction may be used. In this way gradual correction of the deformity may be attained (*redressement continué*), or else correction may be reached at one sitting (*redressement forcé*). Formerly the plaster-of-Paris bandage was used almost exclusively in the treatment of pes varus. The foot was placed in as correct a position as possible in a plaster bandage; at the end of from one to two weeks this bandage was removed, the deformity still further corrected and a second bandage was applied, and so on until the normal position was acquired. The case was considered cured when the foot remained in normal position without being held there and when, in ascending the stairs and in walking, the sole of the foot rested entirely on the ground. Hahn uses a simple means for holding the foot in position whilst the plaster bandage is being applied, and yet not interfering with the operator. This is a T-shaped wooden splint (Fig. 310) which is set in the bandage. Upward traction at *a* and at *d* overcome the equinus and inversion position. In small children, to prevent the bandage becoming soiled by the urine, it is advisable to varnish it and to bind its upper edge with sticking-plaster. Inward rotation must, as far as is possible, be guarded against, and such a tendency may be overcome by tying the feet together and, at night, by fastening a wedge-shaped cushion between them.

The objection to the plaster bandage, that it interferes with active and passive movements, does not hold, for the bandage is changed every eight to fourteen days, when an

opportunity is given for bettering the position of the foot by means of passive manipulations.

For many reasons it is important that the patient should soon be enabled to walk around, and the ambulant apparatuses are, therefore, of great utility. In order to prevent inward tilting of the feet in walking, Roser has recommended a stirrup-shoe, that is to say a shoe provided with an ⊓-shaped stirrup projecting about one inch beyond the sole.

In older children and in adults, the indications for the treatment of club-foot differ somewhat. J. Wolff, in particular, has resorted to redressement in stages by means of ambulant apparatus. He first applies three to four strips of adhesive

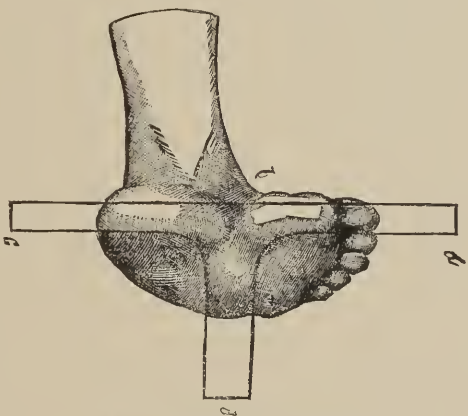


Fig. 310.—Hahn's T-Shaped Splint.

plaster, after Sayre's method, over this a moist bandage, next a silicate-of-soda bandage, and, over all, a provisional plaster bandage, the foot being held in as correct position as possible while this bandage is setting. After the lapse of a few days, the plaster bandage is removed, a second silicate of soda bandage is applied, and over this an ordinary stocking and shoe are worn.

According to Wolff, it is peculiarly important that the patient should walk on the sole of the foot, that is, that the foot should functionate in normal position, for thus the normal architectural structure of the foot will be regained. Such should be the aim of every method of treatment of club-foot. After very forcible reduction (at times after tenotomy, etc.)

the silicate-of-soda bandage should be applied and should be worn for seven to nine months. In severe instances of congenital club-foot, betterment of position is attained at the very outset by cutting a wedge-shaped piece out of the bandage, correcting the position still further, and strengthening the bandage by a second application of the silicate. It may require, therefore, eight to twelve days for the completion of the bandage.

We will now consider forcible redressement of pes varus under anesthesia (König, Wolff) with after-treatment by a retention bandage. With the exception of very young children and of adults with very compact bones, this method is suitable for the majority of cases of club-foot, congenital as well as paralytic, especially in the developmental stage. König operates as follows: The projecting external side of the foot, at the point of articulation of the calcaneus with the cuboid and the lateral border of the talus, is placed against a hard surface. An assistant or one hand of the operator presses the heel firmly against the surface, and the operator, taking purchase on the inner side of the portion of the foot which projects over the fulcrum, corrects the deformity by the weight of his body. This, as a rule, requires two to three séances. The foot is then surrounded by a plaster bandage in order to secure the result, and, where the force resorted to has been great, the foot is suspended vertically. This forcible redressement results in rupture of ligaments, in fracture of fragments of the bone from the concavity, and in splintering of the bone in the convexity. König prefers this method to operations with the knife, seeing that, in his experience, it has been followed by better shape and function of the foot.

Instrumental forcible reduction has also been resorted to and has been recommended particularly for instances of rigid club foot in older children and in adults. Velpeau, Morton, and others have devised apparatus in which screw pressure is utilized to redress the foot. In Fig. 311 is represented the apparatus devised by Kolbe, of Philadelphia. The apparatus consists of a block of wood carrying a padded horse-shoe for the fixation of the heel. The foot is strapped to this block as is represented in Fig. 311. The adduction is overcome by the outward traction exerted through the screws on the eminence of the tarsus and of the great toe, while movements of the block will effect flexion and eversion.

Bradford [41] uses an apparatus provided with padded cushions for the purpose of forcible reduction. Two cushions are applied on the inner side of the foot over the calcaneus and the metatarso-phalangeal joint, and a third on the outer side a little in front of the external malleolus. These cushions are held in position by means of screws, and by means of a fixed rod in the foot-piece forcible pronation, supination, plantar and dorsal flexion are possible. Bradford, as a rule, resorts to this apparatus after he has tenotomized the tendo Achillis and the plantar fascia.

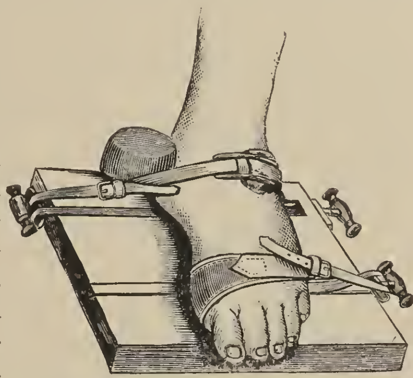


FIG. 311.—Kolbe's Traction Apparatus.

More gradual forcible redressement may be affected through Stillman's [42] club-foot twister, which is represented in and readily understood from Fig. 312.

Before I proceed to speak of the operative measures, I must refer to the various club-foot machines, which, as a rule, are provided with lever- and screw-mechanism, elastic traction means, etc. These machines are only suitable for patients who come under treatment in late childhood. They cannot be used during the early years of life, for then they are ill-adapted to the little feet, readily become inefficient, and may excoriate the foot or induce gangrene from pressure.

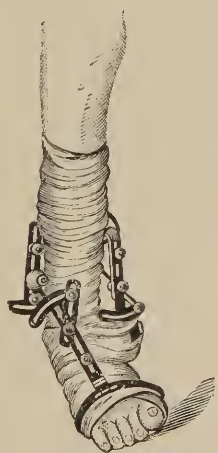


FIG. 312.—Stillman's Apparatus.

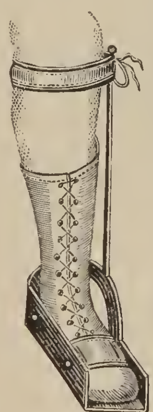


FIG. 313.—Venel's Sabot.

In general, apparatus of this nature is only suitable for the second stage of treatment. In the application, great care must be exercised that the foot

rest thoroughly on the sole and that the splint for the lower extremity is exactly adapted. Ordinarily, apparatus of this nature is provided with means for dorsal flexion, pronation, and abduction of the foot, and also with a device for lifting the external border of the foot, similar to that in Venel's "sabot" which consists of a wooden foot-piece and a lever bar extending along the external surface of the lower extremity (Fig. 313). V. Bruns [43] has modified this simple apparatus by fastening the foot by a number of straps passing through holes in the foot-

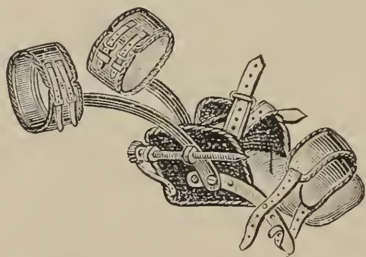


Fig. 314.—Little's Apparatus

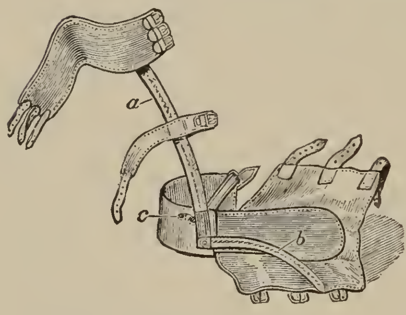


Fig. 315.—Stromeyer's Club-foot Shoe.

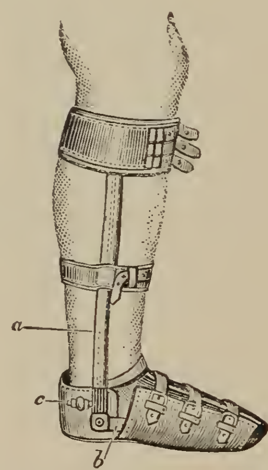


Fig. 316.—The Same, Applied.

piece, and by making elastic traction on the foot by means of rubber tubing extending from the foot-piece along the outside of the extremity to the knee. In this manner the foot is pronated.

The well-known Scarpa's shoe is the type of the sandal-formed club-foot shoes which have been devised by Scoutetten, Delpech, Guérin, Blasius, Günther, Schuh, Martin, and others. These shoes differ, however, in many respects from the original Scarpa model. One of the best known of the many modifications of the Scarpa shoe is Little's. The mechanism in this shoe effectually overcomes the equinus position

and prevents plantar flexion, while offering no obstacle to dorso-flexion (Fig. 314). Stromeyer modified the Scarpa shoe by making the anterior portion of the sole movable, and by attaching the screw, *c*, which allows of the external splint, *a*, being placed in the desired position. The spring, *b*, on the outside of the shoe effects inversion of the foot (Figs. 315 and 316).

Tamplin's modification, as used at the London Orthopedic Hospital, consists of an iron sole, *a*, covered with leather; of a heel-piece, *b*; of an external lateral splint, *c*, attached to the lower extremity by the strap, *d*. The external spring, *h*, everts the foot; the straps, *e* and *f*, maintain the heel in correct

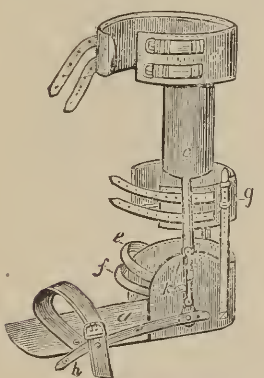


FIG. 317.—Tamplin's Apparatus.

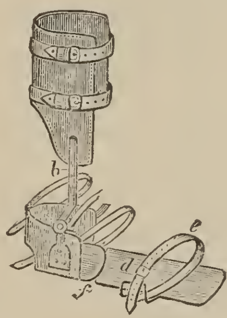


FIG. 318.—Adams' Apparatus.

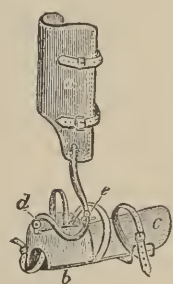


FIG. 319.—Langgaard's Apparatus.

position; the strap, *g*, serves the purpose of fixing the apparatus firmly above the ankle. Flexion and extension are regulated by the screw, *k*, and inversion (eversion) by the screw, *l* (Fig. 317). In Adam's[44] modification the strap, *e*, draws the foot outwards; flexion and extension are obtained by the screw, *c* (Fig. 318). In a later model, in which there is more direct action on the anterior part of the foot without the exercise of lateral pressure, Adams inserted three joints controlled by screws, one at the ankle-joint, a second at the transverse tarsal joint, a third at the tarso-metatarsal joint. Leather straps encircle the upper and lower extremities, and the splint is jointed at the level of the knee.

In Ebner's and in Langgaard's (Fig. 319) apparatus, the sole, *c*, is also movable on the heel-piece, *b*. In Ebner's appa-

ratus there is a pad which exerts pressure on the convexity of the foot; in Langgaard's, an endless-screw, *d*, controls inversion and eversion. In the Sutter-Langenbeck sandal-shaped club-foot shoe, the equinus position is overcome through a screw, and the foot may be pronated and supinated at will by

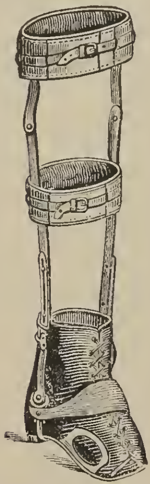
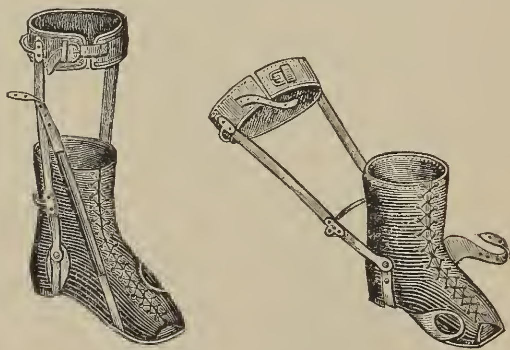


FIG. 320.—Kolbe's Club-foot Shoe, for the Left Side.



FIGS. 321 and 322.—Kolbe's Club-foot Shoes.

means of an endless screw in the lower extremity splint. In Kolbe's apparatus, lateral splints, jointed at the knee and carrying rings, are used for fixation; correction is accomplished

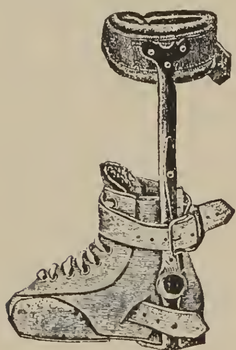


FIG. 323.—Bardenheuer's Club-foot Shoe.

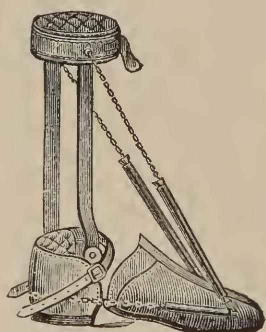


FIG. 324.—Sayre's Shoe.

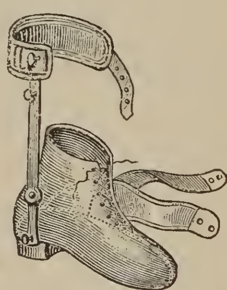


FIG. 325.—Klopsch's Shoe.

by means of turn-screws, and abduction of the anterior portion of the foot is prevented by a strap carried over the metatarsal joint.

In Nélaton's apparatus, the foot may be brought into any

desired position and it may be gradually redressed. In the Robert-Collin's apparatus and in the Heather-Bigg, the mechanism for correction of the deformity is posterior. In Busch's apparatus, the lower extremity is incased in leather; two lateral-splints are united behind the ankle-joint by a nut-joint (enarthrosis) which secures dorso-flexion and pronation, while a second joint of a similar nature in the sole permits abduction of the apex of the foot. Bardenheuer's[45] club-foot shoe (Fig. 323) allows of outward traction and prevents inward rotation, while dorso-flexion is possible and plantar flexion is overcome.

In general, club-foot shoes fitted with screw, etc., mechanism are to-day less in favor, for the reason that the advantage which they possess of enabling us to maintain the foot in the desired position is counterbalanced by the disadvantage that the great pressure exerted may lead to gangrene. These shoes should be used with great caution and be carefully supervised. In many cases, especially in the paralytic variety, apparatus provided with means for elastic traction is to be preferred. In addition to Sayre's apparatus (Fig. 324), we would refer, in this connection, to Blanc's (Fig. 327), where rubber rings supply a continuous correcting force, the foot being effectively pronated and the tendency to plantar flexion being opposed. The mechanism is apparent from the figure.

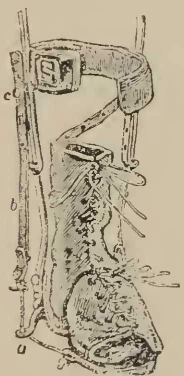


FIG. 326.—Willard's Shoe.


FIG. 327.—Blanc's Apparatus.

The majority of club-foot appliances are intended for use after the chief deformity has been overcome by the plaster bandage, etc. They enable the patient to walk correctly and thus further act as correcting agents.

In Willard's apparatus the heel and metatarsal portions of the sole are united by soft leather, and the elastic band, *b* (Fig. 326), passing through the opening, *a*, and attached at *c*, overcomes adduction of the foot. Stillman adapted Barwell's method of elastic traction to an apparatus which may be used

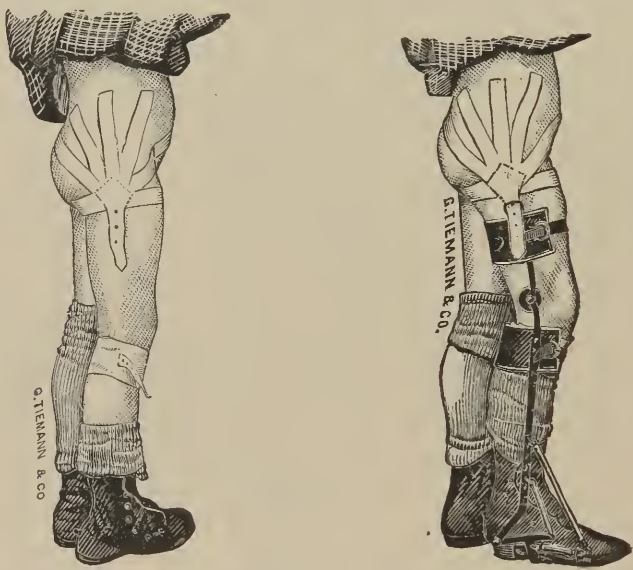


FIG. 328—Stillman's Club-foot Shoe.

with any form of shoe (Fig. 247). The hinge-joint behind the ankle-joint increases the action of the elastic traction. In Stillman's apparatus abduction is acquired and the equinus position is corrected by means of elastic bands (Fig. 328, *a*, *b*). To prevent rotation of the apparatus on the foot, it may be necessary to attach it to the lower and upper extremities by strips of adhesive plaster. Beely, Kolbe, and others have devised shoes which act on a similar principle to Stillman's apparatus (*vide* Fig. 331).

Stillman also endeavored, by means of springs articulated at the ankle-joint, to counteract the tendency of the foot to

rotate inward. In Fig. 329 the spring blade when fastened to the lower extremity tends to pronate the foot. In older children and in adults, in order to complete the cure, it is essential to accustom the joint to maintain the pronated position. With this end in view, manipulations which suggest themselves are useful.

In order to prevent inward rotation of the extremity, that is, in order to favor outward rotation, in the less aggravated instances it suffices to prolong the apparatus as high as the groin and to attach it to the pelvis by a strap or to the thigh by adhesive plaster (Fig. 328). Bruns resorts to elastic traction (Fig. 332), attaching a rubber cord to the upper end of the external blade of the apparatus. This band crosses the thigh posteriorly and is fixed to a pelvic strap on the opposite side of the pelvis. The cord must, of course, be tightened as the traction force relaxes.

Fig. 329.—Stillman's Pulling Spring.

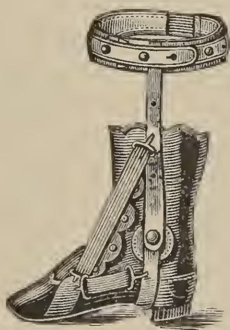


Fig. 330.—Shoe for the After Treatment of Club-foot.

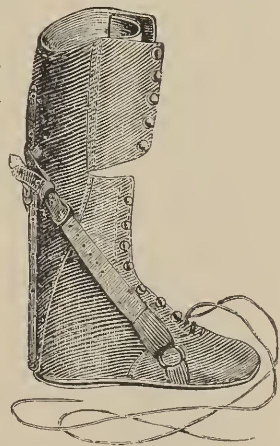


Fig. 331.—Beely's Shoe.

Bonnet's apparatus (Fig. 333) consists of two splints for the upper and lower extremity, respectively, articulated at the knee and ankle. The internal splint terminates in a thigh strap; the external splint extends up to the trochanter and is provided with the ordinary joints for flexion and extension and is also jointed to a steel pelvic band at a right angle. The mechanism of the external splint maintains outward rotation of the leg (*vide* Fig. 29). Meusel's apparatus (Fig. 334)[46] consists of a pelvic strap with upper extremity splint articulating at the hip-joint and fastened at the condyles. The lower portion of the apparatus plays in the groove *a*.

This portion is made up of two splints for the lower extremity, articulating at the knee and ankle and attached to a shoe. The apparatus may be combined with any club-foot machine, and occasionally it is advisable to make the external lower extremity splint somewhat shorter than the internal in order to render the axis of the tibio-tarsal joint a trifle oblique. Doyle[47] has accomplished the same object by means of the spiral rotatory springs represented in Fig. 24. Sayre,[48] to obtain outward rotation, has inserted an endless screw across

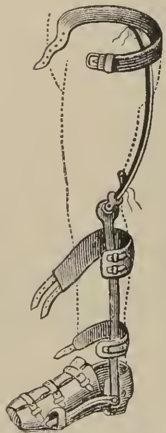


Fig. 332.—Bruns' Apparatus to Overcome Inward Rotation of the Leg.

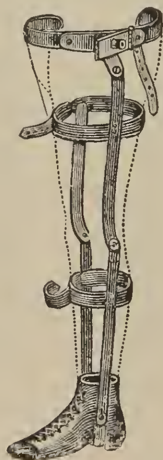


Fig. 333.—Bonnet's Apparatus.

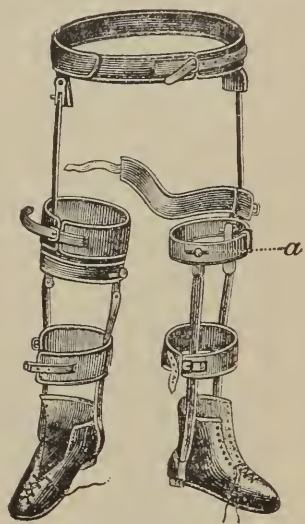


Fig. 334.—Meusel's Apparatus for Overcoming Inward Rotation.

the thigh splint. When this screw is turned, rotation may be accomplished to the extent of three-quarters of a circle.

For the purpose of preventing inversion of the anterior portion of the foot and inward rotation of the extremity, apparatus has been devised with mechanism common to both feet and aiming at keeping the apices of the feet apart. Annandale[49] has adapted to his club-foot apparatus mechanism for everting the anterior portion of the sole as much as may be desired.

Although, for the vast majority of cases, tenotomy is not absolutely requisite, yet this operation will materially shorten

the time necessary for treatment. In addition to the tendo Achillis, the tibialis posticus may call for tenotomy, particularly if it be very tense. While this tendon retains its normal course along the tibia in case of club-foot, below the internal malleolus it becomes stretched. Tenotomy of this tendon should be resorted to from above the internal malleolus (Stromeyer, Vogt) and the operation had better not be performed subcutaneously. A longitudinal incision, about one and one-half inches long, should be made down to the tendon above the internal malleolus; the tendon should be hooked up and cut with a blunt bistoury.

Section of the plantar fascia is also often a very essential step. This operation, originally recommended by Guérin, is to-day chiefly performed after the method devised by Parker[50] and Phelps, that is to say the section of the contracted soft parts on the inner border of the foot. Phelps'[51] method, as performed by Ph. Schede,[52] Nönchen, Cordua, Lauenstein and others, consists in the section of the tendo Achillis, of the plantar fascia, of the tendon of the tibialis posticus, and of the internal lateral or deltoid ligament. The incision is a circular one at the internal malleolus. Following the operation, the foot is straightened and suitably bandaged. Where all the tissues are tense (the third degree of Phelps), Phelps first performs subcutaneous tenotomy of the tendo-Achillis, and next, through an open incision extending between the lower and anterior border of the internal malleolus and Chopart's joint, he cuts all the tendons and the fascia, to the degree requisite for overcoming the deformity. The wound is bandaged antiseptically and, after the lapse of four weeks, a removable plaster shoe is applied, carrying a suitable ¬-shaped iron projection, and the muscles of the calf are subjected to massage and to electricity. In Fig. 335 is represented the case shown in Fig. 295 and treated after this method, and this is a striking instance of the good results attainable.

Fig. 335. — The Case of Club-Foot, Represented in Fig. 295, after Tenotomy and Orthopedic Treatment.

We may now pass to the operations on the bones suitable in case of club-foot, over a dozen of which have been proposed

and in regard to the value of which there is still room for skepticism.

Extirpation of the cuboid bone was proposed by Little in 1854 and first performed by Sully. According to Lorenz,[53] who resorted to this operation in eleven instances with generally bad results, it is only of value from an historical standpoint, seeing that it does not correct the plantar flexion and the internal border of the foot soon re-assumes a faulty position.

Extirpation of the talus has much more in its favor and has been warmly indorsed by Lund, Rupprecht, Reid, Vogt, Böckel, Bessel-Hagen, Margary[54] and many others on the grounds that the arch of the foot is retained, that there are no consecutive disturbances in growth and that there results greater mobility between the calcaneus and the bones of the lower extremity. Lorenz, however, deems the latter point objectionable on the score of likelihood of recurrence of the deformity, and he claims that the operation in the adult will frequently not correct the plantar flexion and that torsion of the foot often remains. According to Lund's tabulated results, the mean time required for union is six to seven weeks, and in this respect, therefore, the operation has nothing in its favor over others. Indeed, extirpation of the talus is advantageous only in so far as it has but little influence on the after-development of the foot.

As regards the technique of the operation, the procedures are various: Reid preferred a lateral, circular incision beginning behind the internal malleolus and extending over the heel to the antero-external side of the extensor tendons. The flap was rolled upward, the foot joint opened and the talus removed. Maas also made a circular incision above the talus. Lorenz found an anterior longitudinal incision sufficient. König[55] carried his incision from the external malleolus above the eminence of the lateral borders of the talus to the side of the extensor tendons below Chopart's joint. Rupprecht[56] resects a piece from the apex of the external malleolus in the belief that thus extirpation of the talus and subsequent redressement is rendered easier. Bessel-Hagen advocates chiselling off obliquely the outer side of the external malleolus. In children the cartilage of the lower end of the fibula must be avoided during any of these methods, lest the bones of the lower extremity develop unequally.

In a number of very aggravated cases it has been necessary, especially in adults, to remove pieces from the os calcis, the navicularis and the cuboid, and even to extirpate one or more of the cuneiform bones before it was possible to overcome the deformity. Hahn also removes a segment from the anterior process of the calcaneus. Albert has enucleated the talus and cuboid, Hahn the talus, cuboid and navicular, and West and Bennet the navicular and the cuboid.

Of the various resections, that of the head of the talus (Lücke, Albert) is performed by preference by Köcher [57] in cases which are not specially aggravated. Lorenz has reported two cases of paralytic pes varus successfully treated after this method and I can add a third case. In severe congenital club-foot the method does not seem appropriate, for it does not of itself remove the obstacle to correction, it being often essential to cut, in addition, the shrunken ligaments and the tendon of the tibialis posticus. Lorenz claims that the method is irrational, being followed by shortening of the inner border of the foot. Hüter's method of the removal of a wedge, with outer base, from the external portion of the neck of the talus has not found favor.

The procedure generally in vogue is wedge-shaped excision from the tarsus (O. Weber, Davies-Colley, Davy, Hirschberg). Lorenz [58] has collected ninety-one instances, the mean duration of treatment being six to seven weeks. This operation best fulfils the indications. It corrects the torsion and curvature and it compensates the plantar flexion. The function of the foot, owing to the subsequent stiffness, certainly cannot be compared with that of the normal foot; still, Mensell, Reid, Schede, and Roser [59] have recorded very favorable results as regards function, especially in connection with the talo-crural joint.

The methods of performing wedge-shaped tarsotomy are varied. O. Weber first removed a wedge from the cuboid and calcaneus. Davy and Davies-Colley removed the cuboid and then portions from the talus, calcaneus, navicular and cuneiform, exceptionally even the cartilage of the two last metatarsal bones. Nicoladoni removed only the caput tali and a piece from the proc. ant. calcanei.

The wedge of bone to be removed should have its apex, as a rule, in the navicular bone and its base in the anterior por-

tion of the neck of the calcaneus and in the cuboid. The tarso-metatarsal joint should be avoided. The base of the vertical wedge naturally lies backward, and the bones must then be resected to a greater extent. Many operators advise the determination of the requisite size of the wedge to be removed by experiment on a plaster cast.

After the removal of the wedge with a sharp chisel—the base of the wedge implicating the cuboid, calcaneus and talus, and the apex the navicularis—the tense ligaments of the sole of the foot must be cut and then, ordinarily, correction is possible. The wound must be dressed antiseptically and the position must be maintained by suitable orthopedic apparatus. Exceptionally the bone suture may be employed, and for this purpose Duret and others recommend *crin de Florence.*

The methods of incision for tarsotomy are also varied. Bryant makes a transverse incision over the dorsum of the foot, extending from the tuberosity of the navicularis to the outer border of the cuboid; a second incision is made along the outer border of the foot in order to cut the extensors. As a rule, however, owing to the displacement of the extensors (*vide* Fig. 279), this latter incision is not requisite. Bush's flap method is objectionable on the score that in case of paralytic club-foot the flaps readily become gangrenous. Albert makes an incision down to the bone along the outer, and a smaller incision along the inner border of the foot. The soft parts of the dorsal and plantar surfaces are next pushed off the bones, and then the wedge is sawed out. In the vast majority of cases, especially when the foot is not large, a longitudinal incision, parallel to the course of the extensor tendons, over the centre of the convexity, will suffice for the operation.

Although now, even under antiseptic precautions, the operations for club-foot are not without risk (Lorenz places the mortality at 1.25% and he estimates the risk to life at nearly 10 per cent), still, without question in chronic cases these operations are justifiable. In infants any operation on the bones must be considered erroneous, and although, owing to the social condition of the parents, extirpation of the talus, etc., is performed in many an infant, still such methods should here be rejected, being, as Lister and Guérin express it, unnecessary mutilation. For by means of suitable orthopedic treat-

ment, associated exceptionally with tenotomy or with Phelps' operation, the foot will continue to develop, even though the appearance of the foot is not essentially bettered (*vide* Fig. 336, *b*).

In the exceptional instances where in children an operation appears essential, enucleation of the talus is the most rational procedure (Lorenz, Rupprecht, and others) since it does not interfere as much with the development of the foot as, for instance, the wedge-shaped excision.

In adults, the conditions are very different and in cases of accidental pes varus resection is the only way of restoring function. In case of paralytic and congenital (chronic) pes

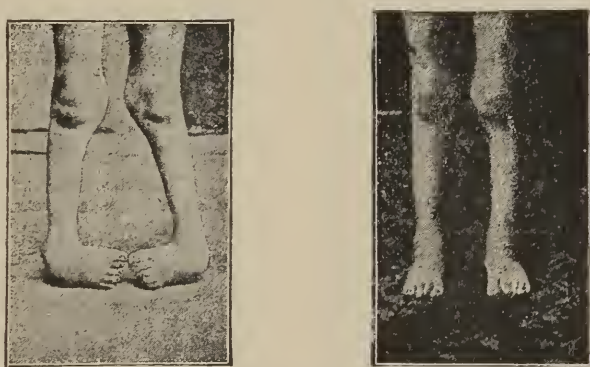


Fig. 336.—*a*, Bilateral Club-foot Before, and *b*, After Tarsectomy (Margary.)

varus at about the twentieth year, mechanical treatment has to overcome such obstacles that wedge-shaped excision here, as well, appears justifiable (Hirschberg,[60] Rydygier).

According to Lorenz, the interests of the patients demand that we should endeavor, by means of tenotomy and section of ligaments and of fascia, to limit the extent of the resection as much as possible. In regard to the choice between wedge-shaped excision and enucleation of the talus, opinion varies. Some favor the former, while the latter has warm advocates, and both methods have yielded good results. We reproduce two of Margary's[61] cases. In Fig. 337 *a* is shown a case of bilateral varus and in Fig. 337 *b* the result after extirpation of the talus, navicularis, and cuboid on the left side. In Fig.

338 *a* is seen a case of left club-foot and in Fig. 338 *b*, the same after wedge-shaped tarsectomy.

According to Bessel-Hagen, the statistics speak in favor of extirpation of the talus. In 122 wedge-shaped osteotomies there were 5 deaths, 45 distinctly bad results, in over 30 recurrence; in 61 talus enucleations, in 11 of which wedge-shaped

Fig. 337 a.—Bi-lateral Club-foot.

Fig. 337 b. After Operation on Left.

excision was also performed, there was 1 death, and 57 good results.

In regard to paralytic club-foot, operations which aim at artificial ankylosis may be resorted to. These operations have been chiefly devised by Albert, and they are particularly adapted to poor patients who live in the country where treatment by orthopedic apparatus is not possible. Lesser and Rydygier[62] have lately described their methods. A longitudinal incision is made over the ankle joint along the fibula to the extent of two inches. A slender wedge, with base outward, is removed from the upper surface of the talus; the

cartilage is removed from the lateral articular surfaces of the talus and from the fibula and tibia; the deformity is corrected and the foot is dressed antiseptically in a fixation bandage. In order to insure the result, the patient should be made to wear a shoe fitted with immovable lateral splints.

Pes Valgus.—Pes valgus (flat, splay foot, *pes abductus pronatus reflexus* [Hencke]) constitutes that deformity where

Fig. 338 a.

Fig. 338 b.

the foot is pronated and abducted. The outer border of the foot is lifted upward, the inner looks downward, and the curvature of the sole is obliterated.

Pes valgus may be congenital or acquired. The latter is by far the most frequent and essential form, the reverse of what holds in case of pes varus, where the congenital form is usually met with.

Talipes valgus congenitus is ordinarily a calcaneo-valgus, and in the majority of instances the deformity is due to ab-

normal intra-uterine pressure (Tamplin, Lonsdale) or position (Lücke, Volkmann, Vogt). Exceptionally it is the result of defect in growth, such as a rudimentary development or defect of the fibula,[63] instances of which have been reported by Wag-

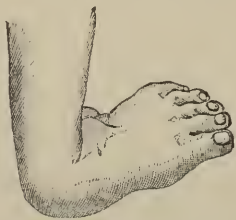


Fig. 339.—Acquired Pes Valgus.

Fig. 340.—Congenital Pes Valgus.

staffe [64] and Meusel. According to Küstner, 8.6 per cent of the cases are congenital. In 764 cases of congenital talipes, Adams found 42 cases of talipes valgus, 15 of talipes valgus on the one side and talipes varus on the other. Of the 42 instances, 15 were on the right side, 10 on the left, and 17 bilateral.

As characteristic points in congenital valgus, Küstner lays stress on the sharply pronated, abducted, and dorso-flexed position. The convexity of the sole is very marked. The dorsum is bent in, and, ordinarily, on the inner border of the foot, the caput tali and the navicularis project strikingly.

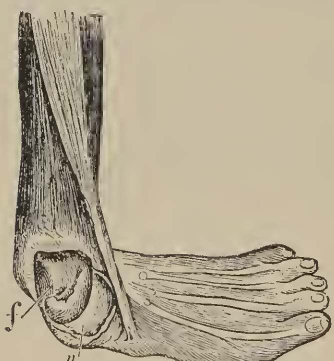


Fig. 341.—Congenital Talipes Valgus.

The anatomical alterations in congenital splay foot do not implicate the shape of the bones to any great extent, even in aggravated instances. As a rule, the heel is only slightly elevated, although, even as in pes varus, it may be sharply drawn upward (Fig. 341). This will vary, of course, according to the contracture of the muscles of the calf of the leg.

The talus is sharply directed forward and downward and is not essentially altered in shape. The navicularis suffers rotation around its antero-posterior axis, its internal portion sinking markedly downward. Its external portion, in slighter degrees of deformity, projects upward. In aggravated cases

there results convexity of the sole of the foot. The cuboid is rotated transversely. The relations of the bones of the tarsus at Chopart's and Lisfranc's articulation are somewhat altered. The ligaments between the talus and the navicularis are generally stretched on the inner side; the muscles are not

FIG. 342.—Pes Valgus Paralytic.

FIG. 343.—Pes Valgus in an Adult.

specially altered. In a number of instances Holl [65] found congenital coalition between the os calcis and scaphoid, and he thence concluded that when such a coalition is determined, it points to the congenital origin of the deformity.

Acquired splay foot is far more common than congenital. The differentiation is made between rachitic valgus (occurring

FIG. 344.—Spastic Pes Valgus in a Girl of 14.

FIG. 345.—Traumatic Pes Valgus Following a Railroad Accident.

in infancy and up to the fifth year) and typical or static valgus (developing at puberty). The paralytic variety (Fig. 342), the spastic variety (Fig. 344), and the variety due to trauma or to disease of the bone (Fig. 345) are very infrequent.

In 999 cases of acquired contracture of the foot, Adams found 181 instances of pes valgus, 80 of equino-valgus, 110 calcaneus and calcaneus-valgus. Rachitic pes valgus results from abnormal softness of the bones and it is usually associated with genu valgum or rachitic curvature of the thigh (*vide* Fig. 42).

Pes valgus adolescentium unquestionably is the result of abnormal lasting pressure, such as protracted standing. This is proved by the infrequent occurrence of the deformity in girls in the higher walks of life, and its frequency, on the other hand, in individuals with relaxed muscles and in those who are obliged to work hard in the standing posture, whence insufficiency of the muscles and relaxation of the ligaments result. It was formerly the belief that atony of the plantar aponeurosis (Stromeyer) and weakness of the muscles, particularly the tibialis posticus and those of the sole of the foot, were the first etiological factors in the production of splay foot; but the fact is, that protracted and increasing pronation of the foot, the result of pressure, constitutes the most essential factor.

There can be no doubt that the etiological cause of pes valgus adolescentium is abnormally frequent and long-continued pressure, and especially constant standing. It is therefore exceptionally rare among girls of the wealthier classes and is most often seen in persons of lax musculature whose growth has been rapid. Flat-foot is frequent in certain occupations for the same reason, letter-carriers, domestic servants, porters, etc., being often affected; their work being arduous and carried on standing, and their hours of recreation and sleep being too short, so that muscular insufficiency and ligamentous relaxation set in. Atony of the plantar aponeurosis has been regarded as the cause of the valgus by Stromeyer and others; weakness of the muscles, especially of the tibialis posticus and the plantar muscles, has been blamed for flat-foot; but there can be no doubt that the above-mentioned permanent position of the articulation, caused by pressure upon the foot, gradually leads to a sinking in and flattening of the arch of the foot: or, in other words, that the permanent and excessive pronation is the immediate cause of pes valgus.

Henke regards the condition a change of position of the component parts of the joint, from the widening of some and

the destruction of others of the articulations, and calls flat-foot *pes flexus pronatus reflexus;* in which view König and others agree with him. Hüter, on the other hand, regards it as a developmental deformity, an unequal distribution of the pressure upon the points of contact of the bones causing unequal growth of these structures. Lorenz has shown the untenability of Hüter's views.

V. Meyer inclines to Henke's opinion, but he regards the change of position of the articular parts not as a direct sinking, but rather as an overturning of the bones; claiming that the internal border of the foot and the lig. calcaneo-scaphoid would necessarily be lengthened if the former occurred.

Lücke [66] says: A complete flat-foot, and a complete abduction-foot (P. plano-valgus) can only occur when there have been changes within the joints, the articular surfaces having separated from one another, and having thereby caused a change in the shape of the bones.

Reismann [67] regards flat-foot as an actual contracture, first of the extensors, and then of the pronators, consequent upon insufficiency of the plantar flexors from over-exertion. But although muscular contracture is the most prominent symptom in some cases, we are not therefore entitled to base the entire theory of flat-foot upon a single phase of the condition.

Lorenz [68] has subjected the various theories of flat-foot to an exhaustive criticism, and I must refer the reader to his work for information. He has shown that an exaggerated position of pronation alone is not enough to cause articular changes similar to those found in flat-foot; for in addition to the motion between the astragalus on the one hand and the os calcis and the scaphoid bone upon the other, which is not rotation upon the axis of the joint, but is rather a motion from postero-externally to antero-internally, there is an actual sliding of the bones upon one another. Lorenz's exact pathologico-anatomical investigations lead him to this result: that "valgus acquisitus is caused by pressure, and consists of a sinking of the external portion of the arch of the foot, together with a partial sliding off of the internal from the external arch of the foot"

During the development of the deformity, there may occur irritative conditions of the periosteum in those places; they being either involved in the displacement (external surface of

the neck of the astragalus, parts of the upper surface of the neck of the os calcis) or they are implicated later in the formation of independent nearthroses (nearthor. calc. fib.; calc. nav.; talo-nav.; Fig. 347) (Lorenz).

The results of such irritation are the osteophytes and bony walls which are almost always found in such situation (Figs. 346, 347); these bony walls forming a kind of "self-limitation" to further development, and accounting for the fact that, under certain circumstances, flat-feet which are contractured

Fig. 346.—The Astragalus in Flat-foot. *x*, Bony Wall.

Fig. 347.—Reflexed External Arch of Foot. *a b*, Nearthrosis Calc. Fibul. (After Lorenz.)

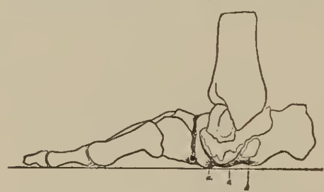


Fig. 348.—Internal Aspect of Flat-foot. *a*, Tub. Nav., which forms a Fulcrum, and which is the deepest portion of the Internal Border of the Foot; *c*, Lig. calc.-nav.-plant., forming an arch between its two points of insertion *a* and *b*. On account of the adduction contraction of the middle portion of the foot, the metatarsus hal. appears shortened.

and with repeated active symptoms are of a more favorable prognosis than those which run a more torpid cause, and in which such a limiting bony wall is not formed in any such degree.

Changes in the bones and articulations, especially in the talo-tarsal articulation, occur in pes valgus acq. These cannot, however, be regarded as resulting from an actual osteitis, but rather as due essentially to the valgus condition of the calcaneus. For the calcaneus is now no longer situated under the middle of the lower limb; the astragalus, which usually rests upon the calcaneus like a lady on horseback (Starke)

has slidden off when the latter bone assumed a position of pronation, and pressed upon and stretched the lig. calc. nav.

The tibia and fibula show nothing abnormal in mild degrees of flat-foot. In the severer grades the point of the malleolus externus is somewhat flattened and rounded off; in the worst cases it is entirely flattened out (Fig. 347). The head of the astragalus is usually very prominent, the scaphoid bone being displaced upon it laterally, and being, at the same time, rotated upon its sagittal axis, so that its tuberosity is entirely beneath the border of the foot.

The astragalus is not essentially changed, the line of insertion of the capsule, even in high degrees of valgus, being on the whole analogous to that of the normal foot. But the relation of the cartilaginous border of the articular surfaces is altered, and the curvature of the astragalus is markedly flattened (Fig. 346).

The articular facets for the malleoli are changed in shape and direction, being displaced anteriorly without being covered with cartilage. While the cartilaginous coat upon the posterior surface of the astragalus is entirely normal, it is deficient wholly or in part upon the middle upper surface. Upon the anterior surface up to the insertion of the capsule it is absent (Fig. 348), the border between the anterior and middle parts being fairly straight and similar to the cartilaginous border in the normal bone. Hence the lengthening of the intra-capsular strip of bone is only apparent, and the internal and external surfaces are of equal breadth. The head of the astragalus is considerably changed in shape; it is divided by an obtuse angle into two surfaces, the greater part of its oval being taken up by the facets for the scaphoid bone. At the inner lower portion of the circumference of the head is the facet corresponding to the lig. tibio-calc.-nav.; and a small flat facet is frequently found in connection with it, for articulation with the median edge of the upper part of the neck of the calcis.

The more pronounced the flat-foot, the more does the apex of the navicular facet recede from the lower inner tuberosity of the oval head of the astragalus. It slips outward, upward, and backward, and the ligamental facet takes possession of the entire inner lower portion of the surface of the head of the astragalus (Lorenz).

In marked valgus the entire surface of the head of the

astragalus is taken up by the ligamental facet, with the exception of a small part of its upper external surface.

In a number of cases the navicular facet has been found displaced beyond the normal external upper border of the oval head on to the external border of the neck; and its continuation is found on the anterior surface of the body of the astragalus in the form of a rounded tubercle with raised edges and covered with coarse fibro-cartilage. In very bad cases the hollow of the scaphoid bone extends over the distance from the upper end of the oval head to the anterior surface of the body of the astragalus, and lies like a bridge over the external constriction of the neck, forming a canalis talo-naviculare. In

FIG. 349.—Talus of a Marked Case of Flat-foot, Viewed from Above and Within. (After Lorenz.) *c*, Upper curved surface covered with cartilage as in the normal; *n*, inner curved surface covered with normal cartilage; *d*, upper curved surface with defective cartilaginous covering; *m*, inner curved surface with defective cartilaginous covering; *e*, (shaded) former extent of the intracapsular ridge of bone; *b*, intra-articular surface. narrowest at *a*; *g*, (shaded) remains of the intracapsular ridge of bone in the talo-nav. articulation.

fact, the navicular bone has suffered an almost complete luxation.

In other cases, the displacement between scaphoid and astragalus causes, by means of periosteal irritation, the formation of an absolute bony wall (Fig. 350), which forms to a certain extent a lengthening of the external upper oval head; it is sometimes irregularly flag-shaped, but is oftenest remarkably regular in its outlines. Its anterior upper surface is rough and irregularly covered with cartilage. In these cases the oval head of the astragalus can be distinctly divided into three surfaces.

In the astragalo-scaphoid joint we find no special alteration in the intra-capsular ridge of bone. At all events, there is no widening at the inner border, as Hüter's theory would demand; it is rather lessened.[69]

In the calcaneus also, the changes incident to flat-foot are

chiefly surface changes; the height of the neck of the bone being not specially affected. Along the external posterior surface of the articulation the astragalus is not in contact with the calcaneus at all, the surfaces being imperfectly covered with cartilage (Fig. 352).

In bad cases of flat-foot, this free border becomes worn down; and the fac. artic. lat. finally is composed of two surfaces meeting at an obtuse angle, the larger anterior and inner

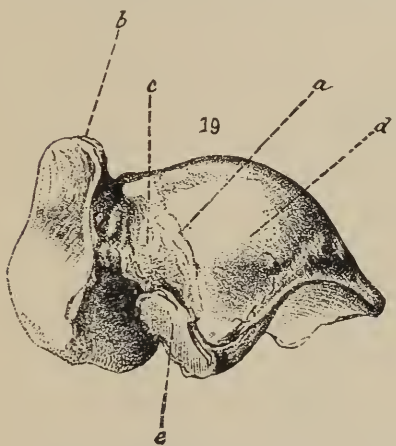


Fig. 350.—Flat-foot Talus from Without. (After Lorenz.) *b*, Ridge of bone on the external upper border of the oval head of the astragalus with nearthrotic surface; *a*, boundary line between the cartilage-covered posterior part of the lateral curved surface, *d*, and the anterior portion, imperfectly covered with cartilage, *c*: *e*, nearthrotic súrface on the anterior margin of the lateral edge of the crest of the talus.

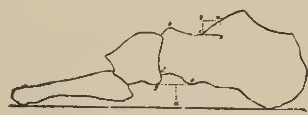


Fig. 351.—External Arch of a Normal Foot Seen from Outside. *ge*, Lig. Calc. Cuboid; *c o*, Profile of the Facies Artic. Lat., the surface of pressure in the external arch of the foot.

Fig. 352.—Sunken External Arch of a Flat-foot (after Lorenz), with the Formation of a Ridge of Bone, the Cuboid being displaced upward on the Fac. Cub. Calcan.; at *b*, the plantar edge of the Fac. Cuboid. rests upon the Lig. Calc. Cub., whose position is shown by *f g*.

one representing the remains of the joint-surface. The shortening of the calcaneus joint-surface caused in this way may be as much as two-fifths of an inch in aggravated valgus.

The joint surface of the sustentaculum tali begins to lose its cartilage at the anterior external and lower border in mild cases of flat-foot, in the worst cases of valgus acq. it may disappear entirely, and the sustentaculum tali may become a rough uncovered tubercle.

With comparative frequency there is found on the median upper border of the edge of the os calcis a cup-shaped facet, which, with the nearthrodic hollow on the anterior surface of

the body of the astragalus, forms a complete bony bed for the scaphoid bone.

Lorenz has also demonstrated the interesting fact that there occurs a movement of the lateral edge of the astragalus on the neck of the os calcis—from behind outward to in front inward.

Like the head of the astragalus, the anterior joint-surface of the calcaneus may consist of two or of three facets.

The under portion of the lower joint surface shows not in-

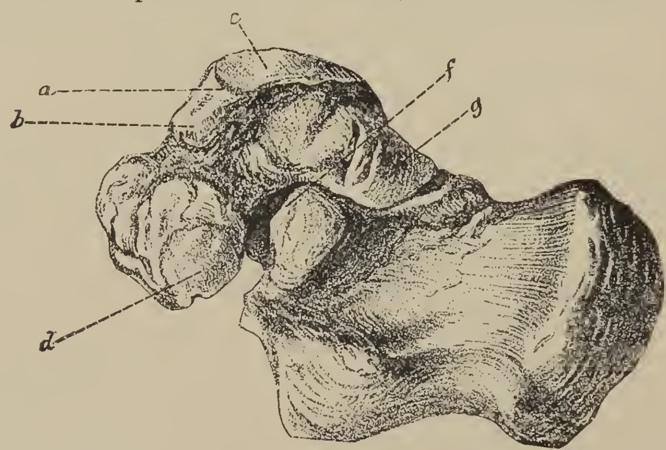


Fig. 353.—Astragalus and Calcaneus of a Flat-foot in their Natural Position, and seen from Within. (After Lorenz.) *a*, Boundary between intact, *c*, and defective, *b*, cartilaginous covering of the median side of the curved surface; the sustentaculum tali, *f*, corresponds to the sulcus tali instead of the facet, *d*, of the talus.

frequently an atrophic covering of cartilage where it is uncovered from the cuboid.

The os cuboideum shows special changes only in the higher grades of valgus, so that its anterior and posterior surfaces lose their normally parallel relationship, the anterior surface becoming inclined forward and perhaps irregular and ridgy.

The shape of the navicular bone is often greatly altered. It becomes wedge-shaped, and its external sagittal diameter may sink to about two-fifths of an inch. Its upper and outer cartilaginous covering may be lost, according as its contact with the astragalus is changed.

As regards the ligaments, flat-foot shows a general loosening (Lorenz). Thus it may be demonstrated anatomically that the ligaments between the astragalus and the calcis permit

movements between the bones in various directions, but especially from behind externally to within anteriorly, just as in a loose amphi-arthrodial joint.

This shows that the ligamenta calc. interossea must have been stretched and become loosened enough to permit of motion between astragalus and calcis.

The lig. talo-calc. is lengthened and changed in direction; in very well developed valgus it may disappear entirely.

The lig. calc. fibulare in aggravated cases forms an acute angle with the fibula; and in case of a nearthrosis between the point of the fibula and the calcis, it may be entirely destroyed.

The lig. tibio-calc.-nav. and the lig. calc.-cuboideum are always stretched and lengthened; while the lig. calc. nav. interosseum, when not destroyed, is always shortened.

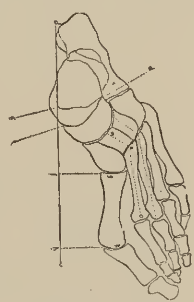


Fig. 354. — Outlines of an Adducted Flat-foot seen from Above. (After Lorenz.) Note the zigzag course of the Axes of the bones.

As regards the positions of the joints in flat-foot, in bad cases the talo-tarsal joint is not only in a position of pronation, but the astragalus appears to have slipped off the calcis entirely. With respect to the articulatio calc.-cuboidea reflexion of the joint occurs when the external arch of the foot is flattened.

The talo-crural joint is in a state of greater or less plantar flexion in flat-foot. This may be considered a compensatory movement, for it is a direct consequence of the sinking of the external arch of the foot. In aggravated cases, the motion of the joint is almost entirely lost, only a slight amount of dorsal flexion being obtainable. The normal arc of motion of 76° to 80° sinks to 45° or even 32° (Lorenz).

Finally, in well-marked cases of flat-foot we must not forget the contracture in adduction of the metatarsi, which gives the inner border of the foot a peculiar zigzag course, as shown in Fig. 354. The head of the astragalus forms the most internal point, and the notching of Lisfranc's articular line can be plainly seen.

If we draw a straight line (*d h*) from the median curved surface, the distance from it to the tarso-metatarsal articulation, in high degrees of flat-foot, is, according to Lorenz, about one and one-half inches instead of about one inch in the nor-

mal pronated foot. The distance, $k\ h$, of the cap. metatarsi from the line will be about one inch, as against one and one-quarter inches ordinarily.

The angle, $m\ n\ s$, formed by tarsus and metatarsus is about 170° normally; it is here diminished to about 135°.

As to the symptoms of acquired flat-foot—as the name implies, they consist mainly of a flattening of the arch of the foot, and a depression of the proc. ant. calc. and of the head of the astragalus (Fig. 355). In rachitic flat-foot, symptoms of rickets in other places will rarely be wanting; rachitic curvature of the limbs being present with especial frequency. A fixed contractured position does not, however, appear to result from the rachitic valgus of childhood.

In pes valgus adolescentium, evidences of early rickets are rarely demonstrable. When the patient stands, more especially, the foot appears broader than normal, clumsy, and turned outward; the arch of the foot and the inner border of the foot are sunken; the heel is more prominent posteriorly, and the tendo Achillis seems tenser than natural. The point of the foot is abducted, the toes are extended, the whole anterior foot is pronated. Under the prominent internal malleolus, *c*, is seen a rounded prominence (flat-foot hump) (Fig. 355). It consists of, first, *b*, the caput tali, below and anterior to this is *a*, the tub. *o*, navicularis. The foot is usually livid and prone to be covered with sweat. Not infrequently the muscles are imperfectly developed, and the veins are dilated.

Fig. 355.—Pes Valgus Ad. *a*, Tub Navicularis; *b*, caput tali; *c*, malleolus int.

The consequences of pes valgus are a heavy inelastic, dragging gait; the patient is easily fatigued and is incapable of much exertion. Hence flat-footed persons cannot serve in the army.

In accordance with the grade of functional disturbance we distinguish a torpid and an inflammatory pes valgus. In any severe case of valgus the functions of the foot are more or less interfered with, the mobility of the astragaloid joint in respect

to dorsal flexion, and that of the talo-tarsal joint in respect to supination, being diminished. Not infrequently the faulty position becomes a fixed one, and the pes valgus becomes a contractured valgus.

In these latter cases, the symptoms become very typical, and the subjective troubles of the patient reach a high grade. Characteristic and violent pains (tarsalgia) appear, located in those joints that are most affected.

The French authors call this condition *tarsalgie des adolescents* (Guérin, Gosselin) or *pied plat v. douloureux* (Terillon), while with us the designation of *inflammatory* or *acute flat-foot* (Volkmann) prevails. Neither term is very appropriate. There is no real inflammation of the joint, but rather localized traumatic irritation of the periosteum, causing the appearance of the ridges of bone above mentioned. The term *contractured static flat-foot* (König, Lorenz) is perhaps the most appropriate one.

The condition usually appears after excessive exertion, a long march, or prolonged dancing. Violent pains, with pronation, abduction, flattening, and especially fixation of the foot in the above-mentioned position mark its advent. In very pronounced cases the tension of the tendons (tib. antic., peronei, Achillis) can be plainly seen; and the muscular contracture becomes more marked when we attempt to overcome it by passive motions. The mobility of the ankle joint is diminished; pronation and supination cannot be effected, since motion between the talus and calcaneus is suspended. There are almost constantly present certain characteristic painful points (Hüter), corresponding to the tuberos. oss. nav., the head of the astragalus, and the processus ant. calc.; for the lig. calcaneo-nav. is tense and stretched and the entire foot is compressed by the extreme pronation. Other painful points in the sole and over the metatarso-phalangeal joints (Lücke [70]) and at the lower tibio-fibular junction sometimes appear. Local œdema occasionally occurs, which has led some observers to predicate the existence of actual inflammatory action (Gosselin, Lanneloque). The contracture that occurs is probably an instinctive fixation by muscular action similar to that which appears in joint inflammations (Roser).

The diagnosis in the early painful or intermittent stages sometimes presents difficulties. Not infrequently a commenc-

ing osteitis, a neuralgia, or rheumatism is diagnosticated (Lücke). When young persons complain of being easily tired when they walk and stand, they should be thoroughly questioned as tc occupation and habits. The foot should be examined and compared with its fellow. If necessary an imprint of the foot should be taken upon paper; for in pes valgus, besides the normal track (Fig. 357) consisting of the external edge of the sole, the ball of the foot and the toes, a greater or less part of the internal border will be imprinted (Fig. 356), in accordance with the amount of the arch that is lost.

As regards the course of pes valgus, there are occasionally three stages: one of development, a painful stage, and a con-

Fig. 356 a. and 356 b.—Print of Sole in Severe Pes Valgus.

Fig. 357.—Print of Sole of Normal Foot.

tractured stage. But the affection may remain stationary at any stage of its development if the conditions which caused it alter. There is usually permanent though not very marked disability (inelastic gait, etc.). If there is marked abduction pain will seldom be wanting. In the higher grades contracture is usually present, and the patient is completely incapable of any protracted exertion.

In the less severe cases the contracture soon disappears if the foot is not used for a day, and cold is applied to it.

Even if untreated not all contractured flat-feet become stiff; and especially in individuals over twenty years of age there occurs an accommodation of the muscles to the changed joint relations. Only in a small proportion of cases is there

nutritive shortening of the muscles; but in these cases a luxation of the peroneal tendons over the malleolus ext. may even occur. The consecutive irritation may interfere greatly with motion, and may even cause complete ankylosis of the tarsus.

Flat-footedness is therefore an affection that deserves attention even in its first stages. By appropriate measures its progress may be checked. The prognosis is best for valgus dependent upon muscular weakness, and is not bad for the rachitic form in its early stages. It is fairly unfavorable, however, as regards restoration of function in marked cases of inflammatory valgus.

Prophylaxis also is possible. Good general nutrition, baths, massage, and the avoidance of over-exertion of the feet, and

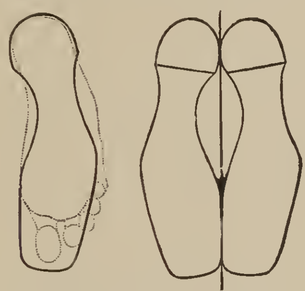


FIG. 358 and 359.—Correct Contour for Shoes. (After Meyer.)

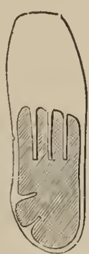


FIG. 360.—Spring Sole Apparatus for Flat-foot.

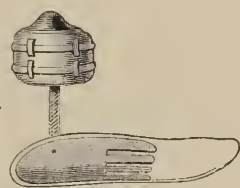


FIG. 361.—The Same with Lateral Piece. (After Beely.)

especially of standing much in beginning cases of tarsalgia—these measures will tend to prevent the development of the affection.

Gymnastic exercises, active and passive motions of the feet, and attempts to walk upon the external surface of the naked feet, have been recommended especially by B. Roth.[71]

The use of electricity, both induced and constant current, is to be recommended. The mechanical treatment of pes valg. cong. consists of mechanical replacement in as correct a position as possible, and fixation there by firm bandages, or Volkmann [72] recommends gutta-percha splints for that purpose, attached to the extremity with bandage or plaster.

Tenotomy is rarely necessary in flat-foot, though Tamplin [73] and others have recommended cutting the ext. communis, the peronei, the tib. antic., and even the tendo achillis.

The rachitic flat-foot must be prevented from getting worse by some supporting apparatus. A flat-foot shoe, which is a Scarpa's shoe with tension in the opposite direction, and with an articulated piece to be applied to the inner side of the leg, may be employed. Suitable anti-rachitic treatment must not be neglected.

In congenital pes valgus, also, when pains appear, a suitable apparatus is indicated. The important point is that the apparatus correct and redress the deformity as much as possible, keeping the foot somewhat supinated, and counteracting the tendency to further flattening of the arch.

The shoes should be laced, and should extend above the ankle. The inner edge of the sole should be thicker than its external margin. The heel should be of medium height (about one and one-half inches), broad, and placed well forward, so that it reaches the region between the calcaneus and the cuboid, so as to keep the neck of the astragalus in its place. The sole should be gradually bevelled off outward, and should have a suitable adduction-curve (Myer, Roser). It is well to give a pattern of a proper sole to the shoemaker.

Soft elastic compresses placed under the arch of the foot were formerly employed. Lorenz has demonstrated their complete uselessness. A properly shaped steel spring, however, suitably padded, such as Reynders has recommended, may be used instead of the crooked thick sole. It should support almost the entire breadth of the foot, and should be split into separate springs lengthways and transversely. (Beely,[74] Wolfram, etc.) Such a sole may be made to fit the plaster model of the foot, and it may be supplied with an internal lateral splint which is fixed by a band above the ankle (Fig. 361). It should not be immovably fixed to the sole. Formerly there was always an internal piece articulated at the ankle attached to the flat-foot shoe. Some recommend bilateral splints fixed to a garter below the knee, or an elastic band attached in the same way to sustain the arch of the foot.

Lorenz recommends an external splint, sustaining the inner surface of the foot with a leather band. His flat-foot shoe has a thick external wall and a cap for the os calcis; it slopes gradually to the external border and backward to the heel, which is broad, placed well forward, and one and one-half inches high.

But patients with flat-foot frequently apply to us only when they suffer pain—when contracture has set in; and even if rest soon eases the pain the patient's ability to work is nevertheless much diminished. No one can reconstruct an arched out of a sunken foot; developed flat-foot is not an object for our therapeutic efforts (Lorenz).

If any operation is to be recomended it is that of forcible reduction under anesthesia into a somewhat supinated position (Roser), with subsequent retention for a month or six weeks by a plaster bandage. The plaster may be replaced in a few days by a starch bandage (König), or it may be covered with leather so that it may be used in the street.

It is conceivable that under the altered pressure-conditions, the anatomical changes may retrogress to a certain degree. But atrophy of the muscles is liable to occur under the permanent bandage.

Tenotomy of the peronei (Barwell) can only be necessary in the rarest cases.

Hausmann mobilizes flat-foot by means of the apparatus which has already been shown in Fig. 249, which pulls the internal border of the foot upward, and the external border downward. In the short time of two or three weeks the most aggravated fixed flat-foot may be brought into extreme supination, and this, if the foot is massaged once daily, without injuring the skin. A removable plaster boot for flat-foot is then employed to maintain the position. A patient can wear such a boot at least three months, even in bad weather. After placing a pledget of cotton in front of the toes, an ordinary woollen sock is put on. A closely folded piece of flannel is then sewed under the site of the arch. A stout piece of paper-maché forms the sole. With the aid of three long plaster bandages a shoe is made which may be strengthened on each side with pieces of sole leather. While the bandage is setting the foot is to be kept pressed into normal position. The dorsum is then cut up, the whole is covered with leather and provided with a sole and a broad low heel.

It is for the paralytic pes valgus that an artificial substitute for the lost muscular tone may be provided by means of elastic traction (Duchenne). The tibialis ant. and post. especially may be thus supplemented. The simplest way is to support the arch of the foot by an elastic bandage running inside

the shoe and attached above to the circular piece connecting the two lateral splints (Fig. 362).

None of the older valgus appliances are much used to-day. I figure here Adams', with an internal lateral spring, an endless screw corresponding to the joint, and a valgus pad on the inner surface of the sole.

It is only in the severest cases of irreducible contracted valgus that bone operations are to be thought of. Our experience concerning them is yet insufficient. Bennet proposed to excise a wedge-shaped piece from the side of the astragalus, without opening the joint.

Ogston [75] attempted to produce a synostosis between the

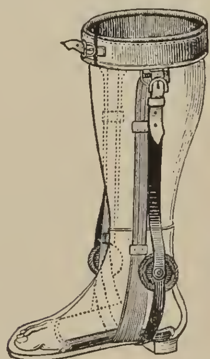


Fig. 362.—Reynders' Apparatus for Paralytic Pes Valgus.

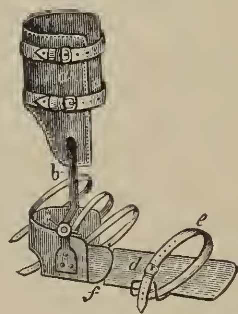


Fig. 363.—Valgus Apparatus. (After Adams.) For Cases of Medium Grade

astragalus and scaphoid bone in the redressed position. By a longitudinal incision on the inner side he exposed the joint and the caput tali without injuring periosteum or ligaments. He then chiselled so much off the articular surface of the head of the talus and the scaphoid bone that redressing could be effected. Then boring two holes obliquely through the navicular bone into the talus, he inserted two iron pegs to nail them together. He then applied an antiseptic dressing and a plaster bandage. After three months he allows the patient to use his feet. Up to 1884 he had done the operation seventeen times, in ten patients. Kendal, Franks, Livàn, etc., recommend it.

Stokes [76] regards the essential change in flat-foot as skeletal, and believes that that of the ligaments is only secondary. He therefore recommends osteotomy of the astragalus. Based

upon one successful case, he directs an incision to be made along the inner border of the foot over the head of the astragalus one and one-half inches long. Another incision meets this at right angles somewhat behind the line of Chopart's amputation incision. After turning back the flap, a wedge-shaped piece of bone, with its base downward, is removed by means of the osteotome from the enlarged neck and head of the astragalus. By adduction and supination the arch of the foot can be re-established. An antiseptic dressing is put on, and Dupuytren's fibular splints maintain the whole in place.

Even extirpation of the talus has been recommended for pes valgus (Vogt).[77]

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CHAPTER VII.

DEFORMITIES OF THE TOES.

DEFORMITIES of the toes are frequently regarded by physicians as hardly worthy of notice; and, though they often give the patient much trouble, he rarely obtains relief. Only a small proportion of deformities of the toes are congenital; most of them are acquired from improper shoeing of the feet; for this latter is the chief factor in the etiology of affections of the toes.

The accompanying figure will show the extent to which the deformity may extend. It is from the Munich Pathological Institute. The small toe is curled over the others, the great toe is reflected dorsally, and the nails have degenerated into long claws.

FIG. 364.—Deformities of the Toes from Improper Shoes.

The toes may be displaced transversely or vertically. The former is peculiarly apt to affect the great toe, and is therefore of especial importance.

Most important of all probably is the external deviation, the abducted contracture, of the great toe, hallux valgus. Instead of being a continuation of the first metatarsal bone, the great toe lies across the other toes, either above or below them. Hence the metatarsus and the great toe form a more or less acute angle with one another, and the head of the first metatarsal bone is more or less abnormally prominent. Not infrequently the bursa over the head inflames, and it may lead to the establishment of a fistulous opening. This extremely painful and disabling condition is a "bunion," in French "oignon." If the inflammation does not go so far as this, callosities and corns may appear.

Hallux valgus is more frequently, though not exclusively, seen in elderly persons. It sometimes seems as if the process

had some connection with chronic rheumatic or arthritic affections. Very marked cases are rare in youthful individuals, although I have recently seen one in a boy of sixteen years. Position in life does not seem to affect its frequency of occurrence. Malgaigne supposed there was weakness of the internal lateral ligament, and he and Dubreuil regarded muscular retraction as the cause of the affection. Nélaton held that there was a retraction of the extensor hallucis. Nevertheless, in most cases the cause is to be found in the wearing of improper shoes, in which the internal border does not form a straight line, and the great toe is therefore pressed against the others (Fig. 365). It occurs the more readily when high

FIG 365.—Position of the great Toe in Consequence of Faulty Pointed Shoes.

FIGS. 366 and 367.—Proper Shape of Sole. (After v. Meyer.)

heels are worn, since then the phalango-metatarsal joint is abnormally pressed upon.

The sharp toe of the modern shoe is not hurtful to the foot if only the inner edge of the shoe is straight and the apex corresponds to the great toe (Fig. 367). The older broad shoe is only partly filled by the toes, which of course have more room for their development.

The anatomical changes in hallux valgus, which Broca first studied, vary a good deal. Not only is there a large callosity, but there appears a bursa, often multilocular, over the prominent head of the metatarsal bone. The base of the phalanx is often displaced entirely from the head of the metatarsal bone, and a new articular surface is formed for it on the side of the latter bone. The head of the metatarsal bone is then covered only with the elongated capsule and the stretched internal lateral ligament; the cartilaginous covering also becomes im-

perfect (Fig. 369). The furrow in which the two sesamoid bones glide is frequently crooked instead of straight. Not uncommonly ossified cartilaginous outgrowths or peculiar

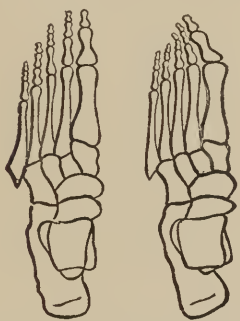

Fig. 368.—Position of Hall. Valg. in Comparison with the Bones of the Normal foot.

Fig. 369.—Hallux Valg. (Transverse Section). *x*, Exostosis.

ridges of bone appear behind the articular surfaces, which (like the similar ones we saw occurring in pes valgus) are to be regarded as the products of periosteal irritation. Sometimes, again, there is an actual exostosis from the head of the metatarsal bone that is thus relieved from pressure—as is well seen in a section of such a preparation (Fig. 369)—only that portion of the head articulating with the base of the phalanx

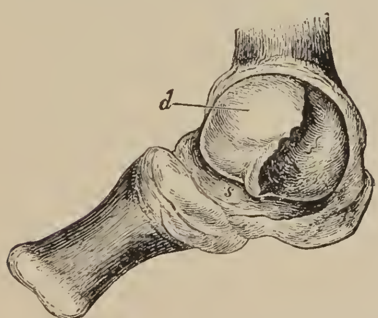

Fig. 370.—Hallux Valgus. Only the Surface, *d*, is in Contact with the Phalanx and Covered with Cartilage.

Fig. 371.—Hall. Valg. in an Elderly Woman.

showing a cartilaginous covering (*d*, Fig. 370). In articular surfaces which are no longer in apposition we find smooth surfaces, fibrillation of the cartilage, etc.; in short, a fairly marked

picture of arthritis deformans. Even the little bones may participate in this process; in several specimens I found their cartilaginous covering wholly or partly gone. The flexor and extensor tendons glide off externally, the soft parts on the external side are shortened, while the inner ones are more or less stretched.

The symptoms of hallux valgus consist chiefly in the abnormal position of the great toe. It is usually situated beneath its neighbors, not above them. We also note the abnormal prominence of the head of the first metatarsal bone. The callosities and bursæ forming upon it may inflame and suppurate. Even caries of the joint may occur. Very much pain and suffering may be caused in this way. Pitha tells of a seventy-five years old surgeon who, driven to desperation, cut off both great toes with a chisel.

The treatment in the first place consists in proper shoes, so avoiding an aggravation of the condition. The boot should be large enough, and its inner edge should be straight. If a painful nodule has already formed over the joint, a slight prominence may be made for it, and a large bunion-plaster can be worn to protect it. In slighter cases orthopedic treatment can consist of a roll of adhesive plaster of appropriate width being wound around the great toe and then passed along the inner border of the foot to the heel, and then back again to the base of the metatarsal bone. Strips of plaster or a roller bandage may be employed for fixation. An elastic bandage may be applied in the same way.

According to Lothrop [1] the finger of a glove may be passed over the great toe, and adduction effected by an elastic band or by plaster.

König recommends forced reduction followed by a plaster bandage; a method, however, which is useless when once the affection has become marked.

Pitha [2] recommended the wearing during the night of a kind of sandal with a spring attached to its internal border, toward which the toe was to be drawn. Similar to this is the apparatus of H. Bigg,[3] which can be worn within the shoe, and consists of a lateral spring with an oval ring for the articular region (Fig. 372).

The tenotomies and divisions of the lateral ligament formerly recommended are not very promising; and the same

may be said of the subperiosteal resection of the head of the metatarsal bone, which Hüter proposed, and Hamilton, Rose, and others recommended. Sayre performed the operation successfully; but it only seems to be indicated in cases of suppuration of the joint.

In all other cases, where there is much disability, or bursal inflammation, a wedge-shaped osteotomy of the metatarsus, such as Barker[4] describes, or the removal of the internal exostosis, as done by Reverdin and by Riedel, is our best resource. With appropriate antisepsis the chisel is the best instrument for the purpose.

Riedel's experience warns us to be careful in these resections; since, after an apparently entirely successful operation of the kind, he was compelled to remove the heads of the other metatarsal bones also, on account of the violent plantar pains caused by the extra pressure on the tarsal bones which made them bore into the sole.

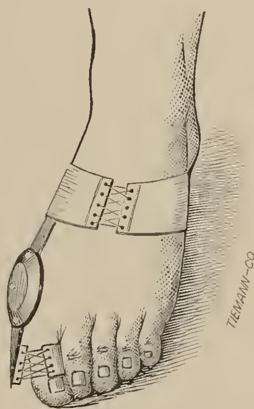

Fig. 372.—H. Bigg's Hallux Valg. Apparatus.

Riedel's experience has taught him that resection is permissible only when flat-foot is present.

Of much rarer occurrence than hallux valgus is the contrary deformity of the great toe, in which it is drawn toward the middle line of the body—the pigeon toe, or adduction contracture.

The affection may occur alone, or with equino-varus or genu valgum. It may cause much spasmodic pain. A sandal with an appropriate contrivance for retaining the toe in the correct position, massage, and manipulation, will as a rule be sufficient to cure the condition. A tenotomy of the abductor hallucis will rarely be necessary.

Lateral deviations of the middle toes, crossed or riding toes, are rarer. They frequently lead to ingrowing toe nail. A suitable footgear is the most important point in their treatment.

Of vertical displacements we have those caused by flexion of the toes, those caused by extension of the toes, and those in which the first phalanx is extended and the others are flexed.

The latter affection is the commonest. Flexion and contrac-

ture of the toe, hammer toe, *orteil en marteau, en Z, en griffe,* is most frequently seen affecting the second toe (Figs. 373, 374).

According to Starke, too short shoes form an important etiological factor of the condition. As a remnant of an essential paralysis passed through in childhood it is prone to affect the great toe. The metatarsi are mostly strongly plantar-flexed, and the toes are dorso-flexed as regards the first phalanx.

Here also cramp-like pains occur, especially after exertion. Callosities are very liable to develop over the metatarsal

FIG. 373.—Hammer Toes.

FIG. 374.—Apparatus for Hammer Toes.

heads that project in the sole of the foot; and bursitis, suppuration, and fistula may occur.

Sandals provided with elastic loops for the toes should be used (Fig. 374). Mollière recommends elastic insoles, to press the caput metatarsi upward. If there is much disability, tenotomy of the extensor tendons or of the plantar fascia is indicated. Appropriate after-treatment, however, must not be neglected. The foot must be fixed to a wooden sandal or a shoe with low heel and an inclined plane for the ball of the foot. Tenotomy of the flexors, practised by Goyrand, is hardly indicated; the division of prominent fasciæ is more likely necessary (N. Smith).

With the smaller toes, if there is much disability and considerable anatomical change, exarticulation is the best method of quickly and radically curing the trouble.

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CHAPTER VIII.

PARALYTIC DEFORMITIES.

The paralytic deformities form a series of characteristic orthopedic affections, and may be caused by various central and peripheral diseases.

Infantile paralysis, idiopathic poliomyelitis anterior, has been well described by Heine. Rilliet and Barthez rather improperly designate it *paralysie essentielle.* It usually occurs in perfectly healthy children of from one to four years of age; but analogous cases have been seen, though rarely, in adults (M. Meyer). After a short initial stage, fever, exhaustion, convulsions, and even sopor occur, followed suddenly by more or less extensive paralysis, usually affecting the lower extremities.

The pathologico-anatomical changes have been especially studied by Charcot, Joffroy, Roger, Money,[1] Kussmaul. The brain is almost always normal; the spinal cord, however, shows acute inflammation of the anterior grey columns (hence called poliomyelitis ant. ac. by Kussmaul). Localized especially at the lumbar and cervical enlargements, the inflammation causes destruction of the ganglion cells and a consecutive atrophy of the anterior roots.

Muscular atrophy is usually readily recognizable, wherefore Duchenne called the affection *paralysie atrophique graisseuse de l'enfance.* But simple atrophy without any fatty degeneration may occur (Laborde).

As regards the frequency of the affection, the statement of Holmes Coote shows that out of 1000 sick children in the Royal Orthopedic hospital, 80, or 8%, suffered from infantile paralysis.

The sudden advent of the muscular disability is characteristic; for without any previous symptoms it may occur in a really apoplectic manner.

Characteristic also is the fact that the paralysis immediately reaches its maximum in extent and intensity, and begins to retrogress in a few days or weeks; so that partial recovery, at all events, is very rapid. In a general way we may say that the paralysis which does not disappear in six months will be permanent.

In more than two-thirds of the cases the lower extremities are affected, and especially the feet (81%, Seeligmüller). Monoplegias are most frequent, and next paraplegias, hemiplegias and crossed paralyses being rare. In almost all cases the paralysis is partial, some muscle-groups being affected, and others being normal.

Thus even when there is marked paralysis of the extremities the ileo psoas and glutæi usually escape, the extensors and the quadriceps femoris being most affected. In the upper extremities it is the muscles of the shoulder and arm that suffer, the movements of the fingers and hands being usually normal.

Fig. 375.—Paralysis Infantilis. (After Rockwitz.)

Atrophy of the affected muscles can usually be demonstrated early, even in two to three weeks (Seeligmüller); the affected part is cool, relaxed, and livid.

Disturbances of sensibility and affections of the sphincters are absent; mild contractions of the muscles may occur from time to time long after the paralysis has set in.

Mental or sensory disturbances do not occur.

The reaction of these paralyses to the electric current is important. The nerves no longer reply to the faradic or galvanic current. The muscles act similarly to the faradic current, but are affected by even a weak galvanic current (there occurring a stronger anodal closure contraction and a weaker cathodal closure contraction). Even after years the galvanic current causes a long-drawn contraction in the affected muscles.

The reflexes are usually much diminished, that of the pa-

tellar tendon being absent. After a time (Seeligmüller[2] has observed pes equinus four weeks after the appearance of the lesion) the altered pressure relations, weight, etc., cause contractures and deformities, especially of the lower extremities. Thus we see contractures of the knee and hip, talipes, and paralytic spinal curvatures. In accordance with the amount of sliding on the floor and bending of the limbs, we have peculiar and often very ugly deformities of the limbs (Heine).

The affected limbs undergo further and further trophic changes; they atrophy, and remain livid and cool. Their growth, also, is interfered with; and hence arise pelvic deformities, static scolioses (Fig. 126), especially when the paralysis is unilateral.

In rare cases all the muscles of a limb may be paralyzed; the patient then has a perfectly lax "swinging leg."

By far the most frequent are the paralytic contractures of the feet, causing equinus most frequently (equino-varus), and more rarely calcaneus, calcaneo-valgus, or pure valgus.

If the foot, from the superincumbent weight and the sinking of the fore-foot, becomes fixed in a position of plantar flexion, one of the most frequent of these deformities, the pointed foot, occurs (Figs. 254, 255), which mostly appears as an equino-varus. This is especially the case in young children that do not walk, there being no counter pressure upon the supinated foot; and also in those who move on crutches after the setting in of the paralysis.

Pes calcaneus and calcaneo-valgus (contracture in dorsal flexion and pronation) are rarer; for the dorsal flexors retaining their power and the plantar flexors being paralyzed, gravity opposes the formation of such a contracture. Only in cases when the foot is permanently used for walking, and is forced into dorsal flexion with abduction and pronation, the muscles opposing the pressure being paralysed, does the disability increase until the meeting bones and tense ligaments stop it. This barrier also, however, ultimately gives way.

In the knee-joint, also, we sometimes find contractures, usually in flexion on account of the preponderating frequency of paralysis of the quadriceps femoris. This is especially the case with children that only creep on the floor or who use crutches; since the knee and hip-joint are then kept flexed to keep the point of the foot from the ground.

As a usual thing the patient's night's rest suffices to counteract the tendency to contracture, and in high grades of paralysis the condition at the knee is rather the opposite one. The joint is abnormally loose and shaky, forming the "schlotergelenk."

The children walk by employing the non-paralyzed extensors of the thigh to bring the knee forward by a kind of jerking motion, and then letting the body weight act so upon the knee that it remains hyperextended. The centre of gravity then falls behind the base of the foot; the pressure of the femoral and tibial joint surfaces upon one another prevents the limb bending anteriorly, and the tense capsule and ligaments hold it in place behind. These latter structures, however, eventually give way, and we then have the hyper-extended knee (Fig. 227).

In the hip-joint contractures from infantile paralysis are rare. If they do occur it is in neglected children, who lie for months curled up in bed, or only creep around upon the floor, or who have used crutches for a long time. Such flexion-contractures of the hip lead to a compensatory lordosis (Fig. 375), since the pelvis must incline itself to correspond to the contracture, and the spinal column must bend to keep the centre of gravity correct.

The function of the glutæi in walking and standing is so to fix the pelvis that the long muscles of the back have a firm point of insertion. When the glutæi are paralyzed, the anterior part of the pelvis sinks downward from the contraction of the psoas and iliacus.

A condition corresponding to genu recurvatum may occur in the hip. There the tension of the lig. Bertini fixes the pelvis posteriorly, and a lordotic curvature anteriorly of the spinal column naturally occurs. If the lordosis is very marked and the ligaments of the hip are relaxed, the similarity of the appearance of the condition to congenital dislocation of the hip (Fig. 386) may be very marked. In fact, cases of paralytic dislocation of the hip in infantile paralysis have been described (Reclus).[3] The contraction of the intact adductors when there is paralysis of the glutæi and pelvi-trochanteric muscles favors the occurrence of such luxations.

In very extensive paralysis the extremity hangs entirely lax, as in a doll; hence the designation, *jambe de polichinelle.*

Paralyses of the dorsal and abdominal muscles always cause anterior curvature of the spinal column. Besides the lordosis there occurs compensatory kyphosis in the upper portions of the column and even skoliotic curvature, in consequence of infantile paralysis. This latter may be entirely static in its nature and be due to shortening of a limb; or it may be due to unilateral paralysis of the muscles of the back and consequent unequal pressure.

Deformities of the upper extremities in consequence of infantile paralysis are much more rare; and the mechanical conditions leading to contractures and deformities are almost entirely absent.

The shoulder joint rarely becomes fixed by the simultaneous contraction of the pectorales and the lat. dorsi. More frequently we find a paralytic subluxation present, in which the weight of the arm has caused the capsule and ligaments to elongate, and the humerus has sunk so far that there is a distinct hollow between it and the acromion. The total atrophy of the deltoid renders the condition still more marked (see Fig. 376). The fingers are flexed into the palms; the hand is slightly flexed. If the hand be more strongly flexed, the fingers may be passively extended. If the fingers be flexed, the hand may be extended to at least 180° (Volkmann). This variety of contracture depends upon the amount of use made of the hand, and also upon whether the flexors or the extensors or both are paralyzed.

Fig. 376.—Right-sided Paralysis of the Shoulder Joint.

Another typical affection, which causes paralyses as frequently as infantile paralysis, but much less commonly leads to contractures, causing mostly pes equin. spast., is the cerebral paralysis of children (hemiplegia cerebr. spast.) (Heine, polioencephalitis acuta). Strümpell has especially studied it, and has located the disease in the cortex.

Pathological anatomy has also shown the presence of atrophic processes, parencephalitic defects in the motor territory of the cortex (cicatricial remains of inflammatory action), frequent embolisms, thromboses, and hemorrhages; but all without any special localization in the gray matter of the cortex (Wallenberg[4]).

The children are apparently healthy and, after a short

initial stage of fever, vomiting and convulsions, are suddenly attacked with the paralysis.

Hemiplegias are commonest, monoplegias more rare. Though the arm is usually affected more than the leg, the paralysis is generally not so complete as in cases of infantile. Most of these children learn to walk again, though the gait may be a halting one.

Ataxia, and a permanent clumsiness for certain motions may be left behind. The intelligence may be disordered; and in right-sided paralyses there may be speech disturbances.

Attempts at passive motion soon show that we have not to deal, as in infantile paralysis, with a relaxed paretic condition; tension of the muscles is plainly present; but the spastic condition rarely leads to absolute contracture.

The muscles and nerves preserve their faradic irritability, and—an important point for differential diagnosis—there is no trace of a degeneration reaction.

The tendon reflexes are not only preserved, but they are frequently exaggerated on the healthy and always exaggerated on the affected side.

But the cerebral paralysis of children is especially distinguished from the spinal by the motor irritation symptoms in the paralyzed limbs. Finger, hand, and arm are not infrequently spasmodically retracted, peculiarly stiff, and occasionally turned. The paralyzed limb shows the same spasmodic tendency; and the hands and fingers especially show the peculiar spasmodic motions, which are generally confined to single peripheral muscle-group. They often consist of comparatively slow motions of extension and flexion, and have been called athetosis by Hammond. The involuntary muscular action is especially liable to occur on intended motion; the fingers and toes are stretched out like claws, and separated; it may occur on one side only—hemi-athetosis. Occasionally these motor-irritation symptoms are so considerable as to become epileptic.

The sensibility of the affected part is usually not much disturbed, nor is the temperature or color of the skin. Crying or fright at passing water, or involuntary micturition may occur. Bladder and rectum are never affected in spinal infantile paralysis.

Paralytic contractures rarely occur. As a rule there is no

other deformity than pes equin. spast. and contracture of the knee, with occasional adduction of the thigh in addition.

According to Heine, curvatures of the spinal cord do not occur in cerebral inflammatory paralysis.

The treatment of these paralyses falls within the domain of internal medicine, and consists of central galvanization, strychnine injections (beginning with one-sixty-fifth of a grain,) baths, hydrotherapeutic cures, etc. Gymnastics, massage, and the peripheral application of the electric current must be lauded; patiently applied we will see the vitality of the affected limb gradually increase. Above all it is necessary to prevent the appearance of contractures and deformities. Thus where the foot tends to sink it should be retained by a bandage in a rectangular position. Ready shaped gutta-percha splints are useful; the foot can be retained in one by a flannel roller bandage or by plaster and elastic bands. Frequently it will be sufficient to heighten the shoe at the side to which the foot sinks, and generally to see that the patient wears laced shoes, which hold the foot in proper position. These children should not be left to themselves. They should be provided with mechanical arrangements and put on their feet (Fig. 378).

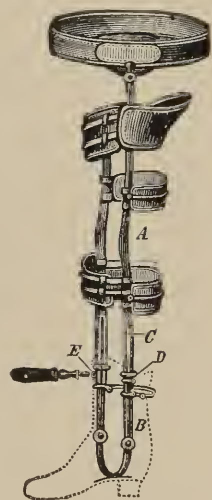

FIG. 377.—Nyrop's Sustaining Apparatus for Paralysis.

The use of crutches must be entirely forbidden; they predispose to the development of deformities. If contractures are already present, gradually increasing manipulation, plaster bandages (sometimes after tenotomy), must be employed to correct them. Various splints and supporting apparatus can then be employed; so that these unfortunate cripples need not drag themselves around like quadrupeds. Such apparatuses are necessarily of varying height, in accordance with the extent of the paralysis. They should be made light and graceful, and fitting well to the limb, without any constrictions, which would further the atrophy. Such machines (Fig. 377) usually consist of side splints with hinges at the joints which can be fixed immovably; they are covered with leather, sili-

cate of soda, etc.[5] Where only a few muscles are involved, artificial muscles, to a certain extent replacing the paralyzed organs, may be employed. Duchenne and others have constructed such with elastic bands of rubber. More will be said about them under the head of paralyses of the hands. Or again, elastic springs, or lateral spiral springs, may be applied to the joint on the paralyzed side, so as to fix the joint when in use.

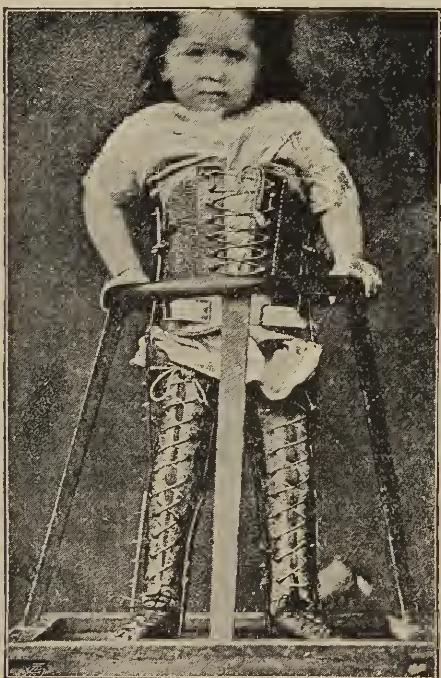

FIG. 378.—Walking Apparatus, for Spinal Paralysis; Papier Maché Apparatus with Movable Hip and Foot, and Fixed Knee Joint.

Charrière, Mathieu and others have constructed rather complicated apparatus of this kind, which have artificial pronators, supinators, flexors, and extensors.

In sublux. paralytica of the arm, to prevent a further relaxation of the capsule, a well-padded leather breast-ring encircling the base of the neck, with a leather capsule for the fore-arm attached to it with straps, may be used. This apparatus is very useful for other purposes also.

In the severest paralyses of the entire lower extremity and the buttock, the splints must reach up to the hips; there must be a good pad over the tuberosity of the ischium, and steel bands must ascend the back or a suitable corset arrangement must be added.

A practical apparatus for the purpose has been described by Heusner,[6] in which the girdle is replaced by complete trouser legs of strong but soft material, to be buttoned in front. They are very secure. The pelvic girdle and the upper part of the lateral pieces is a broad piece of cloth, which is fastened on

with buttons in such a way that the child can loosen it when it wants to go to stool (Fig. 379).

Rockwitz[7] describes an apparatus which he has used in the worst cases of almost complete paralysis of the legs and lower dorsal muscles, after the most troublesome contractures had been removed by tenotomies and extension. It consists of a strong padded corset to extend up the back, reaching almost to the axilla, and sustained by shoulder bands. On each side, somewhat above the hip, are attached pieces to sustain the legs; they reach to the feet, and bear on their inner side the shoe for the reception of the paralytic foot. At the hip-joint there is a flexion hinge, and above that an abduction hinge. The knee can be bent, but is secured by a spring that fixes itself firmly in extension. The splints run inside the limbs, and broad, well-padded rings fix the legs.

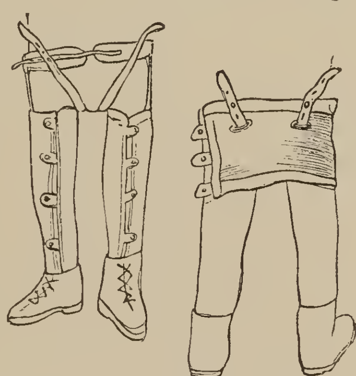

Fig. 379.—Heusner's Supporting Apparatus.

Operative procedures (tenotomies, division of fasciæ, etc.) are frequently necessary before the deformity can be overcome and before we can proceed to the second part of the treatment, the artificial replacement of the function of the limb. Recently other operations have been devised to artificially fix the useless limb and to make it a serviceable support for the body. Albert[8] has designated as arthrokleisis (artificial production of ankylosis, arthrodesis) a series of very successful resections for the fixation of the affected limb, both in the upper and the lower extremity.

Quite recently J. Wolff[9] has described an interesting case of arthrodesis operation in a boy five years old suffering with complete paralytic relaxation of the limb after traumatism.

Winiwarter[10] reports the case of a ten-year-old boy with completely paralyzed lower extremities (infantile spinal paralysis). He formed an artificial ankylosis of the knee first on the right, and a few weeks later on the left side. He then did the same with the tarso-crural joint. As the child died later

of diphtheria he had an opportunity to satisfy himself of the existence of complete bony ankylosis.

V. Lesser, Nicoladoni, Rydygier have practised the operation for paralytic foot contractures (see above).

By congenital spastic rigidity of the limbs, congenital spasmodic muscular contracture, or Little's [11] disease, we mean a group of symptoms characterized chiefly by a tonic spasm of certain groups of muscles occurring with every active or passive motion, with increased tendon reflexes, but with no lessening of the faradic contractility. The preponderant implication of the adductors and flexors of the leg causes a characteristic gait, and a deformity of the foot due to spasm, not to paralysis.

Delpech observed the disease; but Little saw two hundred cases, and first recognized it as a distinct affection. Stromeyer, Busch, Benedict, and Rupprecht [12] have studied it. Seeligmüller, Seguin,[13] Bradford [14] and others have described special cases.

The pathological processes which cause the affection are probably very various. Little believed it to be due to hemorrhages into the brain and cord occurring intra partum, leading to sclerotic processes; Benedict saw the cause in a cerebritis leading to atrophy; disseminated sclerosis, sclerosis of the lateral columns, cortical defects, etc., have been blamed. There is some bulbo-spinal or cerebro-spinal lesion. Premature or complicated births are usually associated with the disease.

It is frequently first noticed when the child experiences difficulty in learning to walk. It may be the fourth year before the child can move at all. There is no paralysis, but a muscular spasm on attempted motion. Brusque passive motion also evokes it. The tendon reflexes are increased; the sensibility is normal, though psychic abnormities, spastic face-play and articulation, laryngismus and spastic strabismus, may be present. There are, however, no trophic disturbances.

The gait is the opposite of that of paralyzed patients. The knees are bent and flexed and the heels elevated. There is a short, tripping walk, for the spasmodic muscular contraction stiffens the legs. The toes are turned in and pointed, so that the patient treads upon their tips.

Rupprecht [15] thus characterizes such a case. If led, the patient can painfully walk a few steps; let alone, he immedi-

ately falls stiffly to one or the other side. If he attempts to grasp anything, there occurs slowly alternating hyperflexion and flexion and finally clinching of the hand. If we attempt to passively move elbow, hip, or knee-joint, it can only be done by overcoming the elastic resistance or the clonic contractions.

To a certain extent the symptoms are similar to those of a compression-myelitis, from spinal caries; but this latter may be distinguished by the deformity of the spinal column and the posture of the trunk. Infantile paralysis is distinguished by the diminished or abolished faradic contractility, the galvanic degeneration reaction, the absent reflexes. A mistake for the acquired form of spastic spinal paralysis is more liable to occur.

The prognosis is unfavorable. Nevertheless, there occurs in many cases a spontaneous diminution of the symptoms. Treatment does much to improve these cases.

The constant current and the cold water cure have been recommended by Erb. Little recommended passive motions and a redressing splint-bandage. Adams and Busch employed a plaster bandage with advantage. Rupprecht used during the night lateral extension, a splint-bandage with dorsal flexion of the foot piece, and a Scarpa's shoe with elastic traction.

Tenotomy is of great value here, improving the walk markedly. The heightened irritability of the tendons when stretched disappears, and movement of the astragaloid joint returns permanently (Rupprecht).

Paralyses of special nervous and muscular areas, pathological or traumatic in origin, may cause certain characteristic deformities. Especially is that the case with the upper extremity.

The ulnar nerve supplies the flexor ulnaris, gives branches to the flexor dig. prof., the muscles of the ball of the little finger, the small flexor, all the interossei, the two innermost lumbricales, and partially the adductor pollicis.

Hence in paralysis of ulnar origin we get ulnar flexion and abduction of the hand, the bending of the three last fingers is hindered partly or wholly, and movement is so interfered with that writing, drawing, etc. is difficult if not impossible.

If the paralysis has lasted long, we get besides the "clawed" position of the hand, *the main en griffe* (caused by

the extensor dig. comm.), a characteristic surface change. The ball of the little finger disappears, and a depression takes its place; the region of the adductor pollicis is flattened; and between both hollows the flexor tendons and the intact muscle bundles of the lumbricales, innervated by the median nerve, form a prominent cord traversing the palm of the hand. The two last phalanges are flexed; the first is dorso-flected (extended). Even dorsal subluxations of the first phalanx may occur; while on the back of the hand the atrophy of the interossei causes deep furrows to appear between the metacarpal bones.

The median nerve supplies the flexor dig. subl., the lateral part of the flexor dig. comm. prof., the flexor carpi rad., the abd. flexor brev., the opponens pollicis, and the muscles of the ball of the thumb with the exception of the add. poll.

Paralysis of median origin seldom occurs alone, being generally part only of a cerebral paralysis. It is characterized by inability to bend the second and third phalanges of the second and third fingers, and inability to bend and oppose the thumb; while flexion of the first phalanx of all four fingers can be effected by means of the interossei.

Hence the thumb is extended, adducted, and ape-like, the index finger is extended, while the three other fingers are slightly flexed in the normal position. The hand has a "command" posture. Further, deepening of the hollow of the hand, prominence of the first metacarpal bone in consequence of the atrophy of the ball of the thumb, flattening of the flexor surface of the fore-arm, are the later consequences of the lesion.

Most important of all, orthopedically, is paralysis of radial origin.

The radial nerve supplies the anterior muscles of the arm, the anconeus, supin. longus, ext. radiales, supin. brevis, ext. dig. comm., dig. V., ext. ulnar., ext. long. poll., ext. dig. ind., abd. poll. long., and ext. poll. brevis. Hence, in complete radial paralysis of traumatic or other origin, the hand is flexed, the thumb is bent under it in adduction, the fingers are median flexed, extension and abduction of thumb and index finger are impossible, and supination of the extended arm (without the help of the biceps) cannot be accomplished. The extensor paralysis causes the approach to each other of the points of

insertion of the flexors; and from the added interference with their function and the paralysis of the thumb, the hand becomes almost useless.

The atrophy of affected muscles in old paralyses of this kind causes flattening of the fore-arm upon the extensor and supinator side, and wrist-drop.

Fig. 380 shows a case of partial radial paralysis from chronic lead-poisoning.

Lead-poisoning occurs in painters and also from the use of

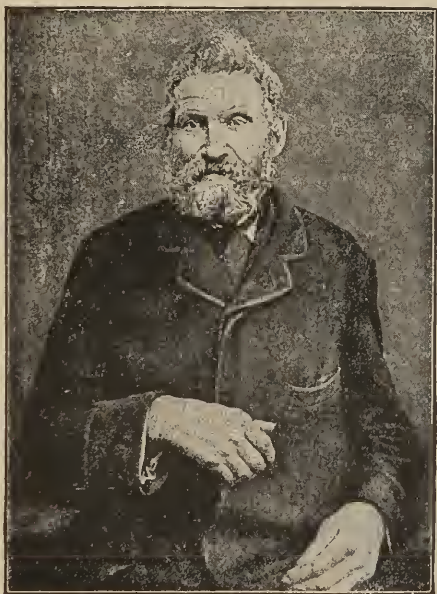

Fig. 380.—Position of the Hand in Lead-paralysis.

lead-containing face preparations (bloom of youth, Sayre). There is extensor paralysis of the hands, which hang down relaxed when the elbow is flexed. The complete impossibility of extension, usually bilateral, gives us a typical picture of an affection which is not likely to be confounded with any other. Besides the use of electricity, iodide of potassium (one to two drachms daily), orthopedic apparatuses are of use. Elastic extension may replace the extensors, and hence prevent nutritive shortening of the healthy flexors. The old Delacroix [16] apparatus is very useful.

Hudson has invented a light and elegant apparatus, which Sayre recommends.[17]

Collin's apparatus is excellent, and is constructed in accordance with a plaster model of the hand and fore-arm (Fig. 198).

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CHAPTER IX.

ORTHOPEDIC AFFECTIONS FOLLOWING FRACTURES AND LUXATIONS.

UNREDUCED luxations and improperly treated fractures fall within the domain of orthopedics.

Improperly set fractures consist of union in false position, either from not properly remedying the original displacement, or from secondary displacement during the period of healing. Hence there remains angular union, axis rotation, or overriding of the fragments.

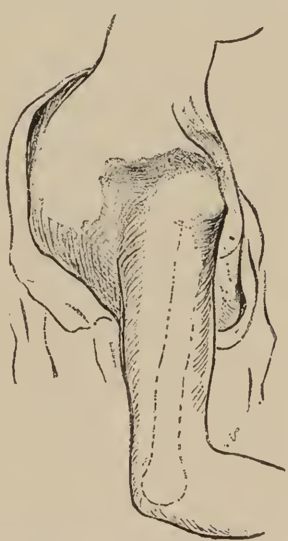

FIG. 381.—Deformity Following Epiphyseal Fracture of the Humerus.

The importance of the condition varies with the grade of the deformity. It is more serious when it affects the lower extremity, when it more frequently requires our care. Gurlt collected 149 cases affecting the lower extremity, 71 being of the thigh and 59 of the leg, against 12 of the humerus and 7 of the fore-arm. Bruns[1] collected 330 cases, 275 of them affecting the lower, and 55 the upper extremity.

Etiologically the fracture may not have been noticed, or no attempt at replacement may have been made, or the retention may have been insufficient from looseness of the dressing or restlessness or delirium of the patient. The muscular peculiarities of the part influence the form of fracture markedly. Thus Bruns found that almost all the faulty fractures of the thigh were situated in the upper half of the bone and were angular outward with shortening. In children, in particular,

fractures are not infrequently overlooked, especially at the epiphyses; for the displacement frequently appears only after the absorption of the large amount of extravasated blood (Fig. 380).

The disturbance caused consists first in the alteration in the direction, length, and shape of the part, but more especially in the consequent diminution or abrogation of its function. And this is not alone the case in the larger bones of the extremities; in exceptional cases we may have to interfere to remedy the results of lesser injuries because the projecting end of the bone caused interference with motion, or even inflammation and ulceration of the skin.

Treatment consists first in seeing that repair goes on in the most advantageous position possible, and occasionally in breaking up the faulty union.

Where the union is not yet very firm and the callus still elastic, the deformity may be remedied by bending or infraction of the callus. This is especially the case in the fractures of children, when, on taking off the bandages, we find that they have not healed correctly, as not infrequently happens, especially with the fore-arm. Duplay says sixty days is the extreme limit of the time after the injury in which this procedure is practicable.

In older cases we have the choice of 1, manual or instrumental osteoclasis, and 2, osteotomy or resection.

The earlier "Dysmorphosteo-palinklasts" (Oesterlen, Rizzoli, etc.) allowed of but a very approximate localization of their action, the newer osteoclasts (Robin, Colin, Beely) are so precise in their action that it is not to be wondered at that instrumental osteoclasis of badly healed fractures is again coming into the foreground. Thus Pousson reports 124 cases. Manual osteoclasis is then reserved for cases of fresh callus in children with the lesion in the middle of the diaphysis of the bone.

Where osteoclasis is impossible, as from adherent scars, etc., osteotomy is in place; and especially longitudinal linear osteotomy. This consists of the separation of the callus uniting the fragments, longitudinally if possible, so that, if necessary, a bone-suture may be applied to insure correct union. Thus Fig. 382 shows a badly-healed supracondyloid fracture of the femur causing genu varum, which was readily cured by

osteotomy. Other operative procedures, such as tenotomy, are sometimes necessary.

In very extensive deformities the excision of wedge-shaped pieces[2] or partial resection may be indicated. When the ends of fragments project toward the skin, it is not infrequently necessary to lay the part open and remove the projection.

In the case shown in Fig. 381 there was ulceration of the soft parts over the sharp edges of the bone. I therefore removed the projecting edge of the diaphysis with the chisel.

Bruns, in seventy cases of antiseptic osteotomy (thirty-

Fig. 382.—Supracondyloid Fracture of the Femur with Consequent Genu-Varum.

Fig. 383.—Pseudarthrosis of the Tibia. (After Fergusson.)

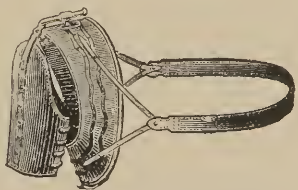

Fig. 384.—Protective Apparatus in Recurrent Dislocation of the Shoulder.

eight linear, thirty-two wedge-shaped), records sixty-six cures without notable disturbance.

Pseudarthroses also may need orthopedic treatment; yet they hardly belong here. Probably where there is marked deformity connected with the condition, removal of projecting ends of bones, resection of both fragments with bone suture or screwing, will be proper; while retention apparatuses will only be employed for the mild cases.

As regards dislocations, the rare cases of so-called habitual luxation may need special orthopedic treatment. Thus Fig. 384 shows Le Fort's apparatus for habitual dislocation at the shoulder joint.

Old luxations also occasionally fall under the charge of the

orthopedist. Although few dislocations are nowadays to be regarded as irreducible, and though even for them arthrotomy and resection may be employed, there are yet cases in which a luxation has either not been recognized, or the patient has not sought medical aid at all. Here there may be considerable disturbance of function, either from faulty position (as in dislocations of the hip and the astragalus) or by pressure upon the nerves (as in axillary dislocation of the humerus). If the possibility of reduction can be excluded, to be determined rather by the condition of the limb than by the length of time that has elapsed, massage and manipulation may do much, especially in youthful individuals, to form a favorable nearthrosis, and prevent ankylosis. In many cases, especially in the lower extremities, there will be no question of anything more than bettering the position of the limb. The accidental fracture of the neck of the femur in the attempt to reduce an old dislocation of the hip (Volkmann and others) has shown us how the abnormal position of the limb may be remedied by osteoclasis or osteotomy where, as in the upper limb, motility is of greater importance (at the head of the humerus, or radius). Resections of the head of the irreducible bone, division of adhesions, will give a fair amount of function. In this way entire resection of the joint will be less often necessary. These measures, to be done under the strictest antisepsis, are, however, no longer in the domain of orthopedics.

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CHAPTER X.

CONGENITAL LUXATIONS.

Congenital luxations are conditions in which the normal relations of the bones composing a joint are disturbed. Though rare, they may occur at various joints: hips, knee, hand, shoulder, elbow, jaw, etc. The most important are those of the hips, which we shall consider somewhat at length.

Most of these cases are due to defective development of the articular head of the bone; rarely do intra-uterine joint affections, paralyses, or abnormal muscular contractions cause them. Since the idea of dislocation presupposes the former existence of normal joint relations, the designations of dysarthrosis cong. (Ammon), congenital malposition (Reeves) [1] would be more appropriate, especially as some of the most important elements of a dislocation, for example the rupture of the capsule, are absent.

Our scientific knowledge of congenital luxations begins with Dupuytren in 1826, though Hippocrates, Avicenna, Paré, Morgagni, Heister, and Paletta undoubtedly observed them. Dupuytren's pictures have been copied in most of the textbooks. Recent investigations show that the condition is by no means a very uncommon one.

By far the most important, as above stated, is the hip displacement (lux. coxæ congenita). It may, however, appear in earliest childhood. The femur is displaced upward and backward on one or both sides.

As regards the absolute frequency of the affection, Parise found it four time in 332 autopsies of new-born children, Pravaz saw 125 cases in sixteen years' practice, and Dopp, at the St. Petersburg foundling asylum, reckons one congenital hip dislocation to twenty-three children with club-foot. According to some observers, its frequency varies in different countries; Albert saw it exceptionally often in the Tyrol.

Hereditary influences are certainly powerful, as Paletta, Schreger, and Stromeyer found. Observations where it occurred in several generations are by no means rare.[2] Nevertheless Adams found this to be the case but once in forty-five times.

Undoubtedly the affection is much more frequent among females. Krönlein found 87.6% of the cases in females; Adams forty-seven females in sixty cases, Albert fifty-eight females in sixty cases. Roser explains this by the adducted position of the legs, which is much more likely to persist in the female during fœtal life. There is some difference of opinion as to its *unilateral* or *bilateral* occurrence. Dupuytren, Langgaard, and others believed the latter to be most frequent; but Krönlein's combined statistics give only 40% of bilateral cases, and Adams, in his sixty cases, had forty-one that were unilateral.

As regards the etiology, there is much truth in Dupuytren's idea that it is a developmental anomaly, the acetabulum remaining undeveloped as a shallow furrow. Dollinger believes it to be due to a premature ossification of the Y-shaped cartilage, in consequence of neighboring inflammatory processes; and Gravitz, though he found no calcification of this cartilage in seven cases, yet supposes the occurrence of its tardy development.

While Adams and others think this is the case in the majority of instances—from the frequently simultaneous occurrence of other malformations, if nothing else—yet they believe that there are other explanations for certain cases. Thus they claim as etiological factors a peculiar position of the fœtus when there is pathological laxity of the tissues, or the absence of liquor amnii (Roser, Lücke). The older authors looked upon fœtal joint inflammations, hydrarthroses (Parise, Verneuil), or destruction of the capsule and the bone (Morel, Lavallée) or intra-uterine convulsions (Chaussier) as causes.

The idea also that traumatisms of the mother's abdomen, or injuries during confinement[2] (Capuron, etc.), might cause congenital dislocation of the hip, has found its defenders. Brodhurst,[3] especially, believed that it usually occurred in breech cases. Sédillot regarded pathological relaxation of the ligaments as the cause. Recently some cases have been explained as due to paralysis of the tensor of the capsule in consequence of infantile paralysis, especially since Lücke and

Roser[4] have attempted to explain some instances as due to paralysis of the pelvi-trochanteric muscles. Verneuil[5] had previously stated that isolated paralyses and atrophies of the gluteal muscles, causing relaxation of the joint, were at the root of the trouble. The pathological findings are quite various. The Musée Dupuytren contains forty-nine specimens of dislocation of the hip, twenty of which are congenital. The variety depends upon whether the specimens belonged to

FIG. 385.—Preparation of a Lux. Coxae Cong. (Mus. Dup.).

children who had not learned to walk, or to adults. Most cases were originally incomplete luxations.

In the new-born, or in children who had not yet learned to walk, the acetabulum was mostly in the normal place, but shallower and smaller than usual, and with its posterior border flattened. The head of the femur also was flattened and atrophied, and rested on the posterior upper edge of the acetabulum. The lig. teres was absent or elongated and thin; the capsule was intact, perhaps a little relaxed; but there was no rupture of it, nor was there any other essential alteration of the pelvis.

Fig. 385 shows a preparation taken from a small child with

right congenital dislocation of the hip. The non-ruptured, lengthened, and hypertrophied capsule; the elongated lig. teres; the small triangular shallow acetabulum, filled with fat; the small conical head of the femur resting against the resistant upper border of the capsule—are all well shown. Absence of the lig. teres, or of the head and neck of the femur was only present in rare cases (Carnochan, Harrison).

In older children we see plainly that the acetabulum has not kept pace with the other parts in its growth; both it and the head of the femur are small and misshapen; the shaft is imperfectly developed or absent; and the older the child the more the neck is placed rectangularly to the axis of the bone. The capsule is toughened and stretched, but normally inserted; it permits great freedom of play to the head of the femur, and is especially thickened where the bone plays against it.

Now, since the rump sinks when the patient walks or stands, the thickened capsule and the ligamentum teres may be eventually worn through. Hence, in grown-up persons, we either find great thickening of the capsule, or perforation and the formation of a nearthrosis. Yet such nearthroses never attain the completeness of the nearthroses that occur after traumatic dislocations.

The pelvis undergoes characteristic changes from the altered pressure relations. In unilateral congenital luxation, the affected side of the pelvis is atrophic, and is dragged upon from before backward and from above and within inward. Thus the illium is forced inward, and more vertically, and the ischium is displaced outward. With bilateral dislocation, on the other hand, the pelvis is distorted symmetrically. Both ilia are forced inward, the pelvic entrance is somewhat diminished in both diameters, and the transverse diameter of the pelvic entrance is somewhat increased. Hence we understand why congenital dislocations do not interfere with delivery (Bouvier, Lassman[6]).

The symptoms of congenital dislocation of the hip consist in the disturbed gait, the uncertain motion, and the deformity.

In bilateral hip-dislocation the child learns to walk very late, and has a peculiar vacillating goose-like gait, with protrusion of the abdomen, marked flexion of the pelvis, and lordosis. There is also elevation of the hips; that is to say, a

fulness above and behind the region of the normal hip-joint (Fig. 386) caused by the displaced head of the bone; in older cases we notice the relative shortness of the lower extremities and the excessive breadth of the hips.

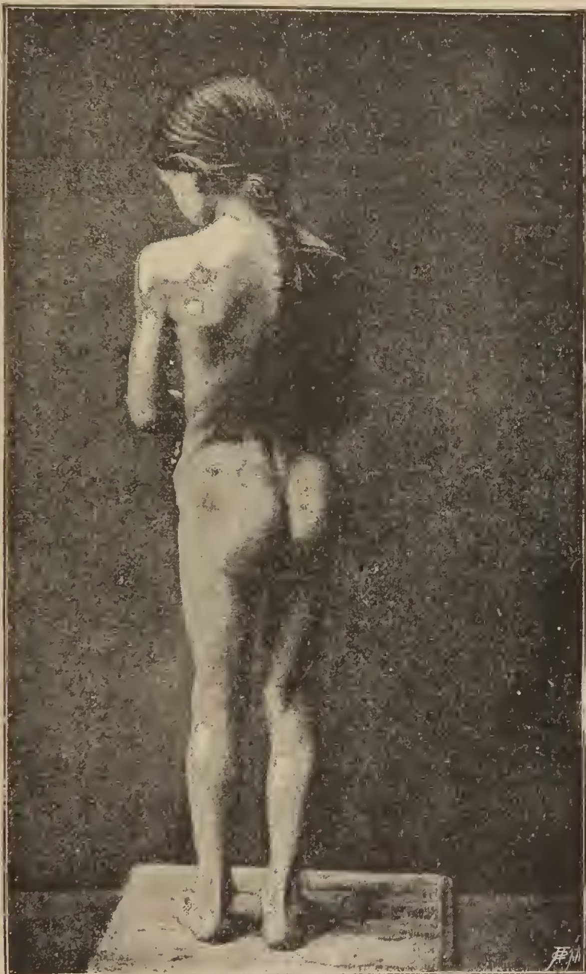

Fig. 386.—Bilateral Congenital Dislocation of the Hip.

In unilateral congenital dislocation of the hip the gait is oscillating and limping; the affected leg is shortened: there is inclination of the pelvis, and scoliosis of the spinal column.

The limb is weaker than its fellow, and is adducted and rotated inward.

The diagnosis of the condition is frequently not made. It is based on the excessive mobility of the joint, while in coxitis and traumatic dislocations the joint is fixed. The limb can be easily pulled back into the normal position, overcoming the lordosis and shortening.

From the slight amount of change that occurs at first it is conceivable why the affection is seldom recognized in very young children. Nevertheless Krönlein[7] made it in two cases at two days and at four months respectively. Besides the absence of pain, swelling, fistula, etc., we find Nélaton-Roser's line above the side of the head of the femur; and the presence of other malformations, and the anamnesis, should help us.

The prognosis of congenital hip dislocations is certainly unfavorable in older cases. In very young cases Brodhurst, and Buckminster-Brown have reported favorable results from treatment; but these are certainly exceptional. In most cases we must be satisfied to prevent further increase of the deformity.

If the condition were more frequently recognized immediately after birth, it would be more often possible to effect reposition, as can be done in most cases of dislocation during delivery. At all events it would be possible, by fixing the thigh in the most favorable position, by passive motion, etc., to obtain a favorable nearthrosis. Unfortunately a large proportion of cases are seen only so late that reposition is out of the question. For a long time our therapeutic attempts consisted only in protracted extension.

Humbert, Jacquier, Guérin, Pravaz, Heine, Behrend, and others claim to have obtained favorable results, even complete cures, by this means; while Dupuytren and others lay most stress on a roborant treatment. Pravaz constructed three apparatuses, the first to bring the head of the bone back into the acetabulum by extension, the second to prevent its getting out again, and the third to increase the depth of the acetabulum.

Very recently a case of cure has been reported by Buckminster-Brown.[8] The treatment consisted of eighteeen months' rest in bed, with extension, passive motion in appropriate directions, and then the use of a wheeled walking apparatus.

Nevertheless, such cases are the exceptions; and in most cases tonic treatment, strengthening of the muscles, retention for long periods of time in the abducted position (Roser), give us most hope of preventing the affection from becoming worse.

For unilateral cases Taylor's coxitis machine, or other apparatuses resting upon the ischial tuberosities, and tending to prevent a further upward displacement of the head of the bone, are most appropriate. For double congenital luxation a variety of apparatus have been proposed by Dupuytren, Bouvier, Stromeyer, Heine, Froriep, Langgaard, Hüter, Schwabe, etc. They are all more or less on the style of the *ceinture à godet* and consist essentially of a pelvic girdle with a hollow lateral pad, whose object is to prevent further upward displacement of the trochanter, and of a circular arrangement for fixing the thigh. The pads, as in Langgaard's apparatus, are fixed by a ball-and-socket joint to a firm rod attached to the pelvic girdle (Fig. 388).

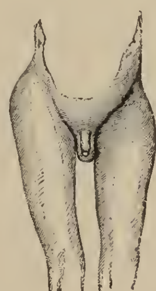

FIG. 387. — Lux. Coxae Cong. in a 14-year-old Boy.

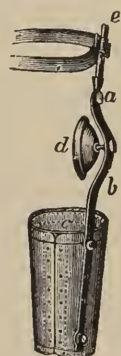

FIG. 388. — Langgaard's Apparatus for Lux. Coxae Cong.

In Kraussold's[9] apparatus the trochanters are fixed from above by movable concave pads which are attached to the pelvic girdle, and are supposed to fit in the region between the anterior superior spine and the trochanter.

The apparatus made by Schwabe[10] consists of a steel strengthened leather pelvic girdle accurately fitted after a plaster cast of the part, with arm pieces and a broad band over the stomach above connecting them, to correct the lordosis. A smooth polished pad, of ivory, hard-rubber, or ebony, is attached to the pelvic girdle. It can be turned in any direction, and with it any amount of pressure may be made downward and inward upon the trochanter. After putting on the apparatus, the patient is placed upon his back, the extremity is extended and the luxated head replaced, and the pad is fixed in the proper position.

All these apparatuses are dear and complicated, and mostly useless. "I have frequently seen children encased in steel," says Adams, "but have failed to observe any advantages derived therefrom." It is therefore readily conceivable that corsets of silicate of soda and other plastic material have been tried. Thus Landerer recommends the application in extension of a silicate corset reaching from the axilla to the trochanter; the trochanteric part is to be carefully pressed in before it dries, so as to make a kind of depression. The corset is then to be slit in front and behind.

Landerer found the working of these corsets very satisfactory, the patients immediately appearing one and one-half inches taller, the lumbar lordosis being straightened out, and the bearing becoming normal. One patient, for instance, who had before not been able to go at all, walked for half an hour immediately after its application. For the case shown in Fig. 386 I had a leather corset made after such a one of Landerer, with the result that his gait improved remarkably.

In those cases where paralysis of a certain group of muscles has caused the deformity, it is proper to attempt to strengthen them by electricity, massage, gymnastics; and these are the cases in which hydrotherapy and the Swedish movement cure accomplish remarkable results.

Guérin, Brodhurst, and others have recommended tenotomy of the pelvi-trochanteric muscles, to remove the opposition to reposition which they occasion; but this can only be necessary in very few cases. Buhring proposed to bore a hole in the bone, and others thought by subcutaneous scarification of the periosteum of the ilium to excite the bone to osteoplastic activity. Mayer seriously proposed to shorten the healthy femur by resection; and Hüter recommended exposing the atrophic head of the bone and removing it, loosening the periosteum from the neck of the femur and the ilium, and by stitching them together to obtain a synostosis or immovable joint connection between pelvis and femur. König believes that in any rational operation we must attempt to fix the head of the femur in a new cavity, perhaps by means of ivory pegs; since even if in a unilateral dislocation ankylosis was the final result, this would be better than the abnormal mobility of congenital luxation. As regards resection of the hip for this deformity we possess a series of observations. Thus

Heusner[11] in a female seventeen years old, after vainly trying Taylor's and other machines, did a resection, removing the elongated head of the femur and chiselling off the edges and enlarging the acetabulum, and obtained a good result.

Margary[12] also tried chiselling out the acetabulum, and has done seven resections for congenital hip dislocation (three unilateral, four bilateral). Rose and Reyher also were compelled to resort to it. For old cases, where the motion of the head upon the pelvic bones causes great pain and disturbance of function, the operation of resection is fully indicated, and has given good results, especially when combined with deepening of the acetabular cavity.

Congenital dislocations of the patella have been observed. They are mostly unilateral or bilateral, incomplete or complete external luxations. When complete, it is only when the knee is flexed that the dislocation becomes prominent or apparent (intermitting form); when incomplete, the patella lies upon the external condyle of the femur, and when the knee is flexed, the patella returns to its normal place. In a few cases the secondary genu valgum was so great, that operative treatment was necessary (Middeldorpf).[13]

Cases in point have been described by Paletta, Wutzer, Caswell, Boyer, Ravoth, and Bessel-Hagen.[14] The amount of disturbance was usually marked, especially on going downhill, or down-stairs. Suitable knee-caps were in most cases sufficient to relieve the trouble. Our main endeavor in treatment should be to gradually correct the position by passive flexion, fixation in the correct position, etc.

In congenital dislocation of the knee the tibia is usually displaced forward with abnormal hyper-extension of the joint; and this may be so great that when the child lies upon its back it may be possible to extend the leg vertically or even to make the anterior surfaces of leg and thigh meet.

Congenital luxation of the foot has also been noticed (v. Volkmann).

Rarer and much less important are the congenital luxations of the upper extremity. Probably most of the cases of congenital luxation of the humerus described by R. Smith,[15] Mayer, and others were of a paralytic nature (Little, J. Wolff). At the elbow there were chiefly noticed isolated congenital luxations of the head of the radius, which, like those of the

hand, mostly depend upon defects in and disturbances of development in the region of the fore-arm.

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